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Idaho National Engineering Laboratory

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SAMPLING AND ANALYSIS PLAN FOR THE ORGANIC CONTAMINATION IN THE VADOSE ZONE OPERABLE UNIT 7-08 FOCUSED REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

(VOLUME I)

I. R. Anderson
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EG&G Idaho

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ABSTRACT

This sampling and analysis plan (SAP) supports the *Work Plan for the Organic Contamination in the Vadose Zone (OCVZ) Operable Unit 7-08 (OU 7-08) Focused Remedial Investigation/Feasibility Study (RI/FS)* (EGG-WM-10149). This SAP supersedes the *Sampling and Analysis Plan for Organic Contamination Characterization (OCC) in the RWMC Vadose Zone Operable Unit (OU 7-08)* (EGG-WM-9834) and the *Sampling and Analysis Plan: Operable Unit 7-08 Vadose Zone Organics Remedial Investigation/Feasibility Study* (EGG-WM-10009).

The objectives of the OCVZ remedial investigation/feasibility study (RI/FS) are to (a) determine the nature and extent of the volatile organic contamination in the vadose zone beneath and adjacent to the SDA, (b) evaluate the risk posed to the public to the environment by the release of volatile organics to the atmosphere and groundwater, and (c) select the best remediation alternative based on the nine Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria. Characterization activities have been developed to assist in the fulfillment of these RI/FS objectives. The objectives of the characterization activities are to (a) estimate the rate of release of volatile organic vapors from the buried waste at the Subsurface Disposal Area (SDA), (b) define the nature and extent of vapor plumes in the vadose zone beneath the SDA, (c) determine the volatile organic flux to the atmosphere and groundwater, (d) determine the transport parameters in the vadose zone and aquifer, (e) measure the organic contamination in the groundwater and perched water below and surrounding the SDA, and (f) provide a sufficient quantity of quality data to prepare the baseline risk assessment for this operable unit.

This SAP includes a quality assurance project plan and field sampling plan. The quality assurance project plan is used during site sampling and analysis to ensure that all data collected are valid, reliable, and defensible. This document outlines organization, objectives, and quality assurance/quality control activities to achieve the desired data quality goals. The field sampling plan is used during site sampling and analysis to provide guidance for all field work by detailing the sampling and data gathering methods.

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ACRONYMS

AEC	Atomic Energy Commission
ARDC	Administrative Records and Document Control
BRA	baseline risk assessment
CCl_4	carbon tetrachloride
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
DAS	data acquisition system
DOE	Department of Energy
EIDMS	Environmental Integrated Data Management System
EPA	Environmental Protection Agency
ERIS	Environmental Restoration Information System
ERD	Environmental Restoration Department
ETSOP	Environmental Technology Standard Operating Procedure
FTL	field team leader
GC	gas chromatograph
$HCCl_3$	chloroform
HPT	health physicist technician
INEL	Idaho National Engineering Laboratory
MEK	methyl ethyl ketone
MS/MSD	matrix spike/matrix spike duplicate
NOAA	National Oceanic and Atmospheric Administration
NIST	National Institute of Standards and Technology
O&MM	Operating and Maintenance Manual
OCVZ	organic contamination in the vadose zone

OU	Operable Unit
PCE	tetrachloroethylene
PD	program directive
PERC	1,1,2-trichloro-1,2,2-trifluoroethane
PID	photoionization detector
QA	quality assurance
QC	quality control
QPP	quality program plan
RI/FS	remedial investigation/feasibility study
RML	Radiation Measurements Laboratory
RPD	relative percent difference
RSD	relative standard deviation
RWMC	Radioactive Waste Management Complex
SAP	sampling and analysis plan
SDA	Subsurface Disposal Area
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
TAL	target analyte list
TCA	1,1,1-trichloroethane
TCE	trichloroethylene
TEM	temperature well designator
USGS	U.S. Geological Survey
VOC	volatile organic compound
VVE	vapor vacuum extraction

1. Quality Assurance Project Plan

Sampling and Analysis Plan for the Organic Contamination in the Vadose Zone Operable Unit 7-08 Focused Remedial Investigation/Feasibility Study

1. QUALITY ASSURANCE PROJECT PLAN

1.1 Project Description

This quality assurance project plan has been prepared to fulfill the requirements stated in all applicable Environmental Restoration Department (ERD) program directives. Other requirements for this document are stated in the *Quality Program Plan for the Environmental Restoration Department* (EG&G Idaho 1991a).

The Organic Contamination in the Vadose Zone (OCVZ) Operable Unit 7-08 (OU 7-08) Focused Remedial Investigation/Feasibility Study (RI/FS) (EG&G Idaho 1992a) is being conducted to characterize the overall nature and extent of risks posed by the release of volatile organic compounds (VOCs) into the vadose zone under and around the Subsurface Disposal Area (SDA) at the Radioactive Waste Management Complex (RWMC). The overall objective of the Focused RI/FS is to gather sufficient information to support an informed risk management decision regarding optimal remedial technology selection.

See Section 2.8 of this sampling and analysis plan (SAP) for a schedule of field sampling/measurement tasks.

1.1.1 Project Objectives

The objectives of this Focused RI/FS are to (a) determine the nature and extent of the volatile organic contamination in the RWMC vadose zone, (b) evaluate the risk posed to the public and to the environment by the release of volatile organics to the atmosphere and groundwater, and (c) select the best remediation alternative based on the nine Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria (EPA, 1988b).

The data obtained from sampling will be used to (a) project the rate of release of organic vapors from the buried waste at the SDA, (b) estimate the volatile organic flux to the atmosphere and groundwater, (c) determine the transport parameters in the vadose zone and aquifer, (d) estimate the organic contamination in the groundwater and perched water below and surrounding the SDA, (e) to prepare the baseline risk assessment for this operable unit, and (f) refine data quality objectives for further investigation and monitoring of the vadose zone below the RWMC.

Justifications for the tasks outlined in this SAP are included in the OCVZ Focused RI/FS Work Plan, Section 5 (EG&G Idaho 1992a).

1.1.2 Site Background

The RWMC, located near the southwestern corner of the Idaho National Engineering Laboratory (INEL), was selected as a waste disposal area in 1952 by the Atomic Energy Commission (AEC), predecessor to the U.S. Department of Energy (DOE). The RWMC was established in 1952 as a disposal site for solid low-level waste generated by INEL operations. This selection was based on the near surface geohydrological studies conducted by the U.S. Geological Survey (USGS) and AEC selection criteria. The RWMC occupies 144 acres. Buried wasted is contained in the 88-acre SDA. See Figure 1-1 for the RWMC location at the INEL and Figure 1-2 for a map of the RWMC. In addition to waste generated at the INEL, waste from DOE's Rocky Flats Plant near Golden, Colorado, and other DOE facilities are stored and disposed at the RWMC.

The current RWMC mission is to provide waste management for the present and future needs of the INEL and assigned DOE offsite generators of low-level waste and transuranic waste, and to receive, examine, and certify stored transuranic waste for ultimate shipment to the DOE Waste Isolation Pilot Plant in Carlsbad, New Mexico.

Refer to Section 2 in the OCVZ Focused RI/FS Work Plan (EG&G Idaho 1992a) for more details on RWMC site background.

1.1.3 Existing Data

In 1987, chlorinated VOCs were discovered in groundwater at the RWMC (USGS 1988). VOCs were also found in:

- Drinking water (EG&G Idaho 1989)
- Samples of perched water (EG&G Idaho 1989)
- Soil-gas samples (EG&G Idaho 1989)
- Ambient air above the soil surface (EG&G Idaho 1988).

To date, the VOCs detected include:

- Carbon tetrachloride (CCl_4)
- Trichloroethylene (TCE)
- Chloroform ($HCCl_3$)
- 1,1,1-trichloroethane (TCA)
- 1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113)
- Tetrachloroethylene (PCE).

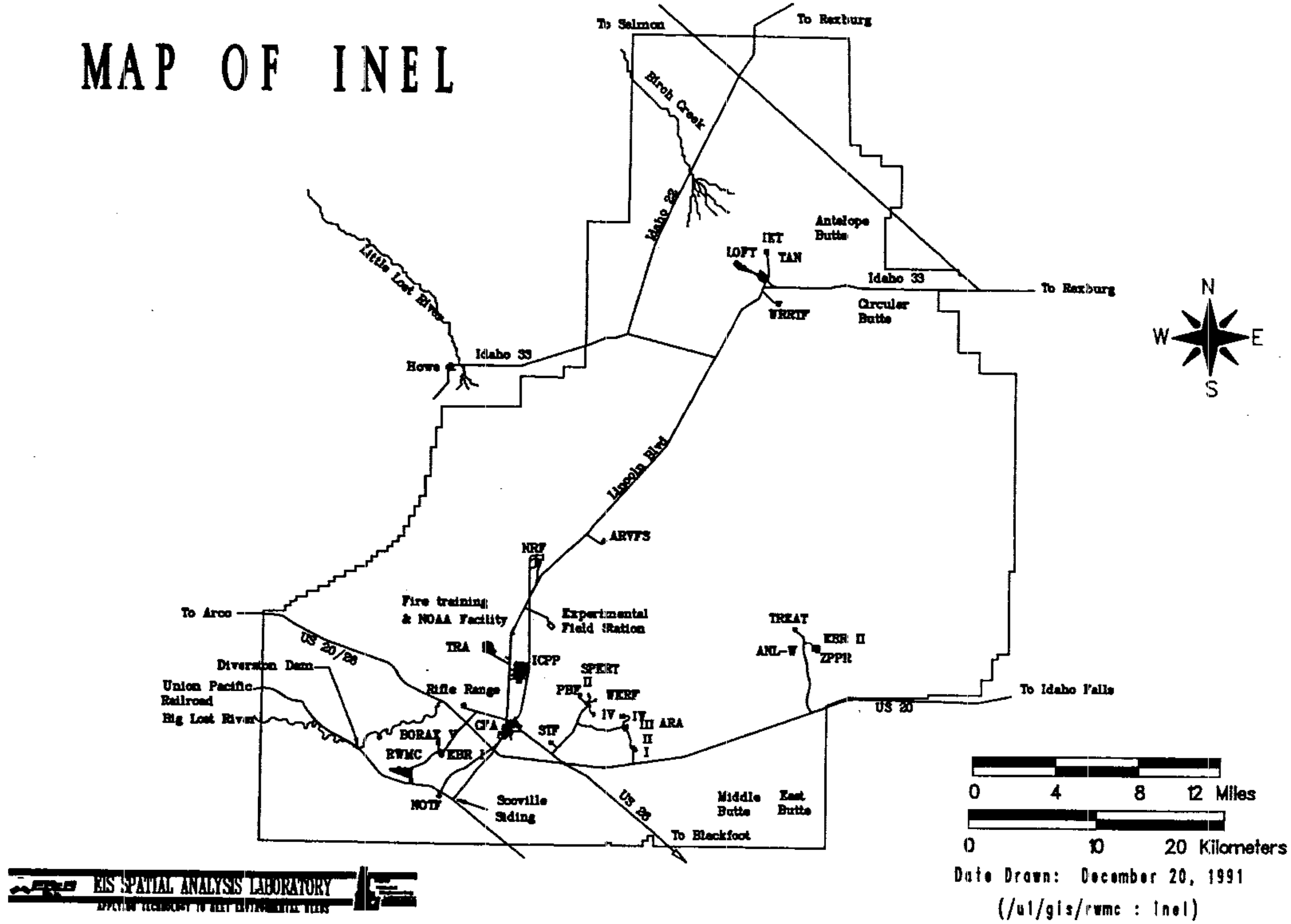


Figure 1-1. Map of the INEL.

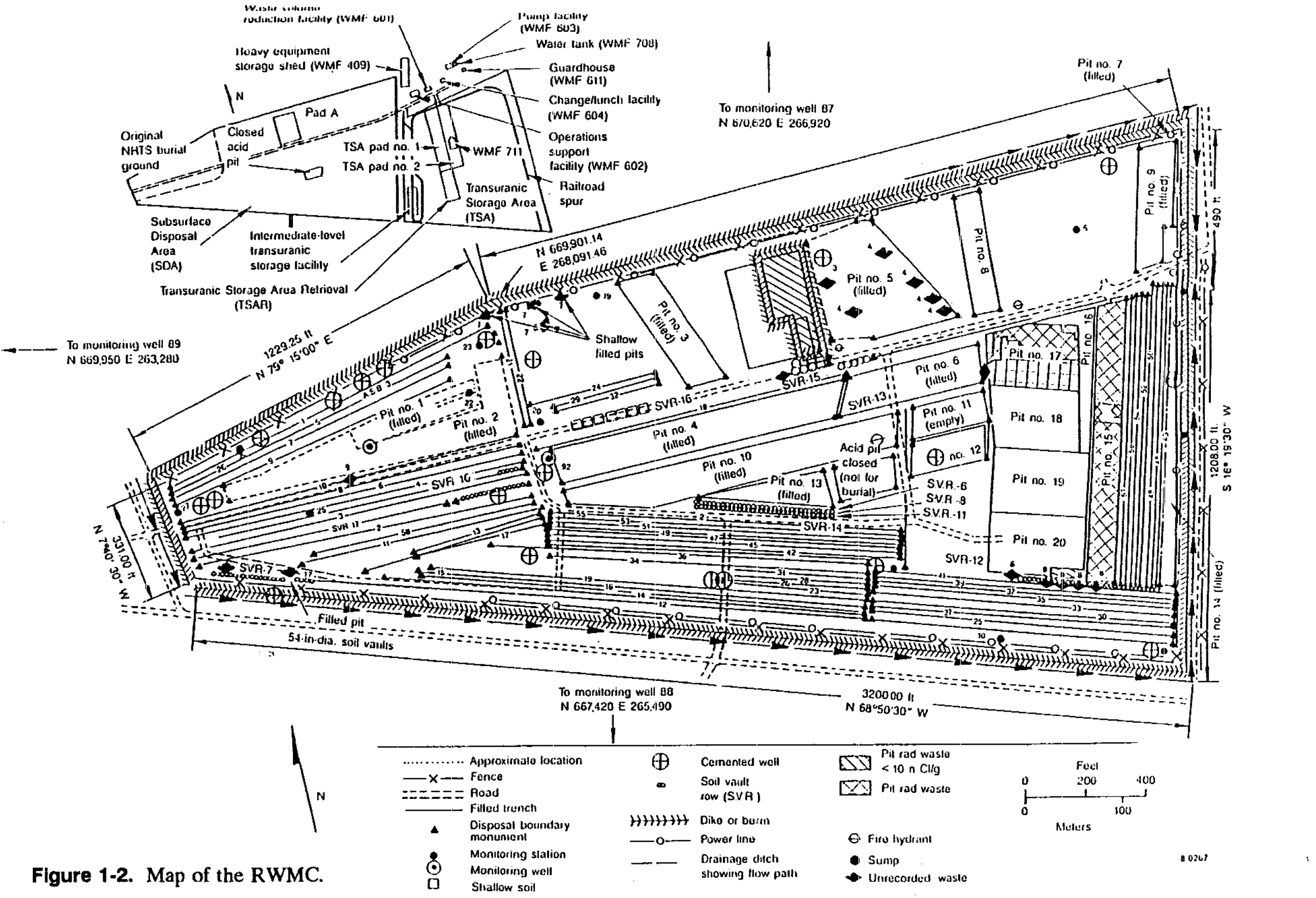


Figure 1-2. Map of the RWMC.

Refer to Section 3 of the OCVZ Focused RI/FS Work Plan (EG&G Idaho 1992a) for further details of previous characterization of volatile organic contamination at the RWMC. In addition, Section 4 of the Focused RI/FS Work Plan provides an evaluation of available data.

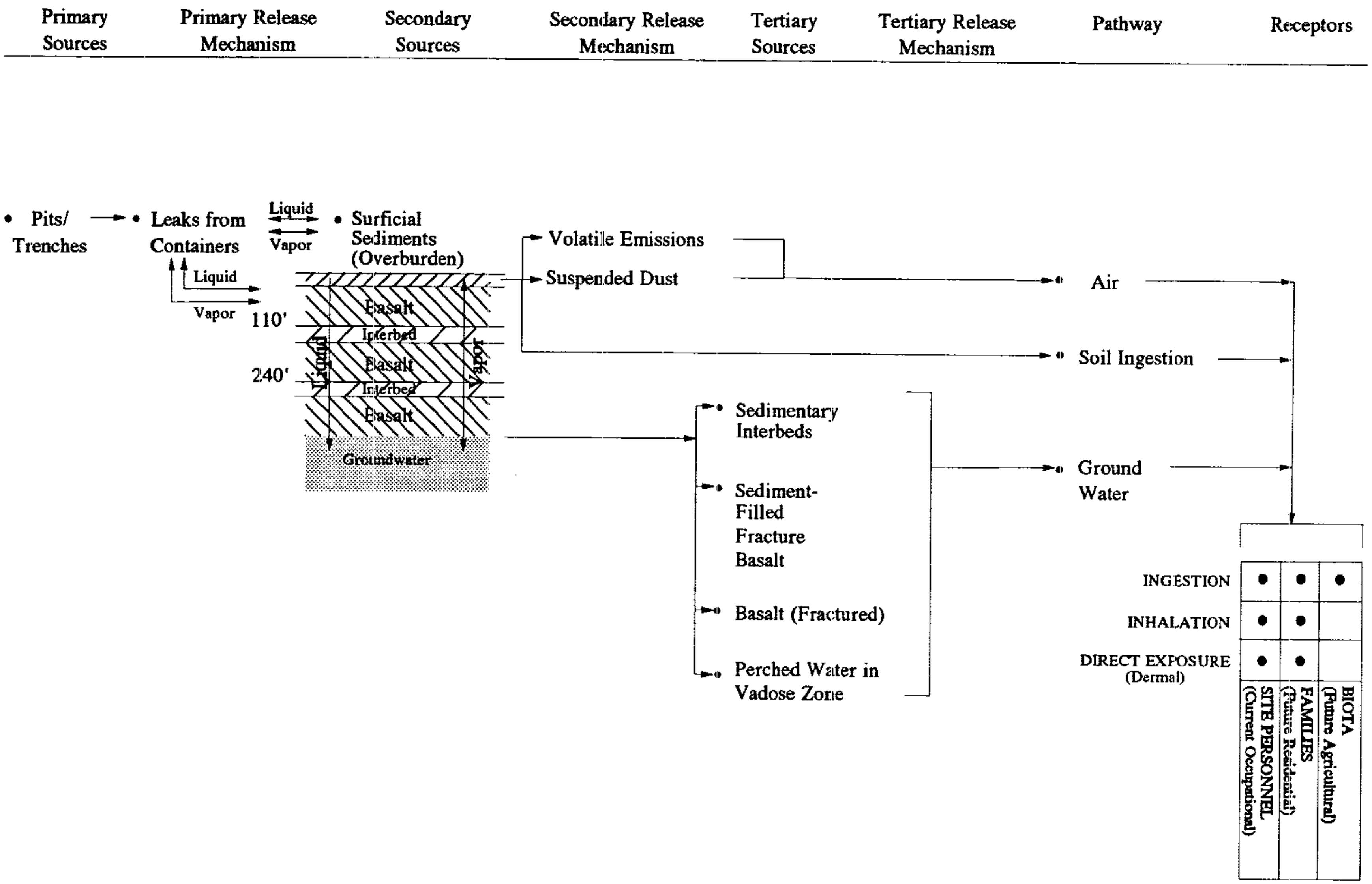
1.1.4 Pathway/Receptor

A pathway/receptor site model has been developed to support the requirements for conducting this remedial investigation according to draft Federal Facilities Agreement/Consent Order and CERCLA guidelines. Figure 1-3 depicts the possible sources, release mechanisms, pathways, exposure routes, and receptors for the contaminants thought to be present in the SDA at the RWMC. The use of this information allows a conceptual evaluation of the potential risks to human health and the environment. Additional details and discussion of this pathway/receptor model can be found in Section 3 of the OCVZ Focused RI/FS Work Plan (EG&G Idaho 1992a).

1.1.5 Sampling Tasks

The following list outlines the various tasks planned in the OCVZ Focused RI/FS. These sampling, measurement, and data collection tasks were selected in order to provide a sufficient quantity and type of data to meet the project objectives stated in Section 1.1.1. The scope of the Focused RI/FS and related sampling activities are subject to change with concurrence of DOE Idaho Field Office, Environmental Protection Agency (EPA), State of Idaho, and EG&G, Idaho. See the OCVZ Focused RI/FS Work Plan (Section 1.1) for the updated scope of planned sampling activities. A brief description of each planned task and corresponding data use follows. Detailed procedures and sampling locations can be found in the field sampling plan (Section 2 of this document). Section 5 of the Focused RI/FS Work Plan provides additional details describing the rationale for these tasks.

1. **Soil Temperature and Vapor Concentrations.** Paired wells will be drilled to the top of the basalt west of Pit 9 and near wells USGS 92 and 8801D. These wells will be instrumented at multiple depths with vapor sampling ports and thermistors. Vapor ports and temperature recording devices will be placed at 2-ft increments from approximately 2 ft below land surface to the bottom of each well at the basalt surficial sediment contact. A data acquisition system (DAS) will be used to record temperature every two hours the remainder of the remedial investigation (approximately 10 months). The vapor ports will be sampled on a monthly basis for up to 1 year, and analyzed for VOCs, including carbon tetrachloride, chloroform, and trichloroethylene, using a portable gas chromatograph (GC). Temperature measurements will be recorded to correlate with sample collection. The resulting data will be used to assess the near surface vapor concentration gradient and relationship to temperature and depth, and will subsequently be used to refine the modeling of the VOC plume.



	SITE PERSONNEL (Current Occupational)	FAMILIES (Future Residential)	BIOTA (Future Agricultural)
INGESTION	●	●	●
INHALATION	●	●	
DIRECT EXPOSURE (Dermal)	●	●	

Figure 1-3. RWMC vadose zone preliminary pathway/receptor model.

2. **Vapor Port Monitoring.** There are currently six boreholes at or near RWMC SDA (three within SDA and three outside SDA) that have been instrumented with gas sampling ports. Each of these boreholes contain five to nine gas sampling ports (a total of 42 vapor monitoring ports) at various depths to monitor VOCs. Six new groundwater wells outside the SDA, with at least 36 vapor monitoring vapor ports at various depths (approximately 6 ports/well) to the aquifer (585 ft) will be installed during the Groundwater Operable Unit, Track II investigation. In addition, approximately six vapor monitoring ports will be installed in USGS Well 118. Some of these ports will be at a depth greater than 240 ft. Ports within the SDA will be sampled weekly. Ports in wells located outside the SDA will be sampled every other week. Six existing open wells within the SDA will be isolated with inflatable packers, and samples will be taken from selected depths. From these six wells about 22 samples will be obtained. Five percent of all vapor port monitoring will be sent to an outside laboratory to be analyzed for VOCs. A vacuum pump will be connected to vapor port outlets and a vapor sample collected in a tedlar bag. VOC analyses of the soil gas will be performed with a field gas chromatograph calibrated for carbon tetrachloride, cholorform, and trichloroethene. The VOC vapor concentration data from these ports and wells will be compared against the VOC plumes predicted by transport modeling. That comparison will be used to validate the modeling of site-specific transport parameters. Initial results from vapor port monitoring shall characterize the subsurface vapor contaminant plume and determine baseline levels of VOCs in the vadose zone.

3. **Perched Water.** Perched water samples will be collected quarterly from five wells (USGS 92, 8802D, 78-1, 77-2, and D-10) using a bailer if there is standing water. Water levels will be recorded prior to sampling and physical parameters (pH, temperature, and conductivity) will be measured at the sample site. Water samples will be analyzed for volatile organic compounds; semi-volatile organic compounds, metals, anions, alkalinity, and radionuclides as specified in Table 1-2. The VOC data will be used to further define the nature and extent of vadose zone VOC contamination, as well as refine the conceptual organic transport modeling. The data obtained from other analyses will supplement the Groundwater Operable Unit investigation. The volume of samples available for analyses may be limited, therefore, priority will be given to VOCs, metals, anions, alkalinity, and semivolatiles, in that order. If water is limited, the priority may be changed by the field team leader (FTL) to ensure at least each of the constituents will be tested once and preferably twice over the sampling period. The volumes of samples submitted to the laboratories may be reduced, with concurrence of the laboratory, if the volume is limited. All samples will be screened for gamma emitting radionuclides prior to shipping. Perched water samples will be collected and analyzed for VOCs, metals, anions, and gross alpha/beta and gamma radionuclides quarterly and semivolatiles semiannually for the duration of the remedial investigation. If gross radionuclide contamination is present in samples, isotopic analysis will be performed.

Americium and plutonium were detected in samples in 1974, 1976 and 1977. The single detection on these dates (that have not been detected on 17 subsequent samplings) represent samples that are not believed to be representative of the perched water. These analysis probably reflect cross contamination or analytical error. The semi-volatile, metals, and radionuclides are analyses of opportunity and the resulting data will be forwarded to the appropriate operable unit. The 17 subsequent samplings, taken twice yearly occurred in the years 1972 and 1979 through 1988.

4. **Vapor Port Permeability.** Permeabilities of the basalt and sediments to air are needed for input into the VOC transport modeling. Permeability of the basalts varies by depth and relative position under the SDA. Because permeability is an important parameter in modeling and simulating VOC transport, improved estimates of permeability at each port location are important information. The permeability tests require pumping gas from each port, while simultaneously monitoring the flow rate and port pressure over time. A pressure transducer is lowered into a sample port. A vacuum pump and flowmeter are then connected to the port. The pump is started and pressure changes are recorded on a data logger. In addition to permeability at each port, the sample volume required to obtain a VOC concentration sample representative of a particular zone will be obtained. Each sample port must be characterized concerning the volume of soil vapor that needs to be pumped to yield a VOC sample that is representative of the vapor plume at a given depth. This test will be performed at all vapor ports on all six existing vapor port monitoring wells, the vapor ports on the six new groundwater wells and USGS 118 to assist in determining the subsurface permeability and optimizing port purge times for vapor plume monitoring. Additional QA will be provided by off-site analysis of 5% of vapor port monitoring samples.

5. **Basalt Tracer Studies.** Tracer tests consist of injecting a tracer gas at one point in the system and monitoring its concentration at other points in the system. Improved estimates of the travel times from point to point in the subsurface would enhance understanding of the existing transport phenomena. Monitor ports installed in monitor wells completed in the basalts can be used to inject and monitor tracer gas diffusing through the basalts and interbeds and defining transport properties in these horizons. Result parameters that can be estimated from these tests are effective diffusion coefficients, dispersion coefficients, and sorption properties. A continuously released tracer gas [sulfur hexafluoride (SF_6)] will be used to measure horizontal and vertical carbon tetrachloride vapor diffusion and dispersion in the basalt. Port-to-port tracer concentration measurements over time for a single well and adjacent wells will be used. These data will be used to refine the BRA. Carbon tetrachloride is the primary contaminant of concern, other VOCs are not expected to contribute significantly to the risk.

6. **Downhole Barometric Pressure/VOC Concentration.** Review of the VVE test results has raised the point that some of the variation seen in VOC concentrations may be related to barometric effects. The purpose of this study is to generate data consisting of three data sequences: (1) barometric pressure, (2) VOC concentrations, and (3) the rate of barometric pressure change. A 50 ft depth port will be utilized because vapor movement in basalt reacts to barometric pressure changes. Barometric pressure is currently being obtained under other tasks at hourly intervals. VOC concentrations are being obtained under a different task of the VVE, however, a more frequent sampling program is required for correlation to the barometer and rate of barometric change. The barometric correlations require samples from periods of rising and periods of falling barometric conditions. To obtain data at the required times, an automatic sampler capable of collecting and storing at least 14 samples will be connected to the 50-ft-deep sampling port in well 8801D. Samples will be obtained at 12-hour intervals. Selected vapor samples will be analyzed for VOCs using the field GC based on the barometric pressure. The basis for sample selection will be a rising and falling barometer. If it is determined from the barometric data logger that the barometric pressure has changed over that period, the samples will be analyzed for VOCs and any changes will be noted. If no barometric change is observed, the samples will generally be discarded and the automatic sampler restarted. Periodically, samples taken during no barometric change will be analyzed to test the null hypothesis. The effect that barometric pressure has on vapor concentrations will be measured. A DAS will record downhole barometric pressure while an automatic sampler collects vapor samples at the same depth for subsequent analysis via a portable GC.

7. **Meteorological Data.** A summary of the USGS and/or National Oceanic and Atmospheric Administration (NOAA) data will be used to supply the necessary historical meteorological data. Various meteorological parameters (wind speed, wind direction, precipitation, temperature) are collected from a USGS monitoring station on the SDA at the RWMC. Barometric pressure will be monitored using calibrated pressure transducers and a data acquisition system (DAS). The objective of this task is to gather past and current meteorological data for the SDA locale to aid in the characterization/modelling of transport and diffusion of VOCs.

8. **Stratigraphy and Structural Geology.** Stratigraphy and structural properties of the vadose zone beneath the SDA have been evaluated in past studies. Extensive drilling, coring, and logging operations have been conducted for the RWMC. A comprehensive literature survey study will be performed to compile relevant data. The objective of this study is to develop a description of geological stratigraphic section and describe geological features most influential in VOC migration in the vadose zone. These geological properties will be determined from geophysical logging operations as well as evaluation of subsurface cores.

Further investigations will be made from information gathered during the drilling of the six groundwater monitoring wells in the groundwater operable unit. Coring of the 110-ft and 240-ft interbeds characterize the sedimentary interbeds in the aquifer. These cores will be obtained to determine if the extrapolation of information from shallow depths is appropriate. The geologic characteristics need correlation and interpretation to stratigraphic control points. Subsurface data should be used to estimate the paleo-environment during deposition of the deep interbeds. This would provide an estimate of sediment properties within the interbeds.

Five types of geophysical logs have been performed in boreholes at the RWMC. These are gamma-ray, gamma-gamma, neutron, resistivity, and caliper logs. A downhole television log was run. These logging procedures will be performed on the six groundwater monitoring wells being installed under the groundwater operable unit.

Gamma-ray logs indicate the amount of natural gamma radiation emitted from material surrounding the hole. Gamma-ray logs are used to identify sedimentary beds within the basaltic sequence. Sediments at the SDA emit more gamma radiation than basalt.

Gamma-gamma logs measure the intensity of reflected gamma radiation from a source within the probe after it has been backscattered and attenuated within the hole and surrounding rocks. Gamma-gamma logs measure the relative density of material surrounding the probe. The logs, therefore, are also used to indicate relative porosity. Basalts show up as high density materials, whereas the sediments have a low density. Therefore, gamma-gamma logs suggest greater relative porosity in sediments.

Neutron logs measure the hydrogen content of material surrounding the hole, thereby reflecting the relative moisture content of the material. Sediment interbeds or fracture zones with sediment infilling within the basalt intervals typically indicate the highest moisture content. High levels of moisture fill the existing porosity reducing the effective porosity and vapor transport properties.

Resistivity logs provide a detailed picture of the character and thickness of various strata at the well site and an indication of the water quality by measuring the apparent resistivity of the materials surrounding the well bore. These logs also aid in well design and construction.

Caliper logs measure the diameter of the borehole. Knowing the diameter of the borehole allows for determination of the amount of borehole erosion that has taken place during drilling, the presence of swelling clays or resistant basalt layers in an otherwise friable rock, fracture patterns in basalt, volume of filter pack or cement grout required for well completion, positions of casing welds or joints, and areas where the casing has separated. Data from a hole caliper log is also extremely valuable in analyzing data for other types of logs where the readings are influenced by variations in hole diameter.

Borehole geophysical surveys along with detailed geological logging will spatially identify water-bearing zones in the vadose zone, aquifer porosities, and possibly fracture geometries; outline site specific geological controls on water movement; and define the site specific stratigraphy. Geophysical surveys and geological logs from the deep well or wells will provide stratigraphic information and geological controls on water movement deep within the aquifer.

During the Groundwater Operable Unit (7-06) Track 2, coring of the 110-ft and 240-ft interbeds for six wells near the SDA will be performed. These cores will be tested for physical properties (i.e., density, porosity, gas permeability, etc.) and analyzed for chemical content (volatile organics, semi-volatile organics, inorganics, metals, and radionuclides).

9. **Open Well Vapor Sampling.** The open (uncased) well sampling activity consists of two parts, (a) well gas sampling and (b) shallow well screening.

(a). **Well Gas Sampling.** Subsurface soil vapor will be collected from 9 existing open wells and the extraction well (8901) at the following specified depths:

USGS 92:	214 ft (bottom), 130 ft, 80 ft
8802 D:	220 ft (bottom), 130 ft, 80 ft
77-2:	86 ft (bottom), just above basalt/surficial soil interface
78-1:	83 ft (bottom), just above basalt/surficial soil interface
D-10	224 ft (bottom), 130 ft, 80 ft, just above basalt/surficial soil interface
8801T:	50.7 ft (bottom), just above basalt/surficial soil interface
79-2	212 ft (bottom), 130 ft, 80 ft
DO-6A	50 ft (bottom), just above basalt/surficial soil interface
76-5	245 ft (bottom), 130 ft, 80 ft, just above basalt/surficial soil interface

The inflatable packer system will be used to pack each well off at the selected depth. Samples will be collected using a Tedlar bag and analyzed using a portable GC. A baseline study of all subsurface vapor sample points will be performed. The sampling frequency and locations will be adjusted on the initial results. For planning purposes frequency is estimated to be quarterly for the duration of the RI. These data will be used to further define the nature and extent of vadose zone VOC contamination, as well as refine the conceptual vapor transport model.

(b). **Shallow Well Screening.** Wells and boreholes at the RWMC that are less than 20 ft deep will be screened using a portable organic vapor monitor. If total vapor levels exceed 100 ppm at the bottom of the well or borehole, a sample will be collected for GC analysis. The screening sample will be collected by lowering a Teflon tube to the bottom of the well and pulling a sample through the organic vapor monitor. If the concentrations exceed those stated above, the well will be purged, capped, and sampled the next day. These data will be used to further define the nature and extent of vadose zone VOC contamination, as well as refine the conceptual vapor transport model.

Vapor samples will be collected from open wells and analyzed by portable gas chromatography methods for volatile organic compounds including carbon tetrachloride, chloroform, and trichloroethylene. Five percent of the well gas samples will be sent to an outside laboratory for analytical support level V volatile organic analyses. The results of these analyses will help determine the VOC concentrations in the vadose zone above the 240-ft interbed. Vapor sampling of specific zones in the open wells will be achieved with down-hole packers. Details of the packer sampling procedure are outlined in the open well test plan (Appendix H).

10. **Groundwater Quality and Elevation.** Data collected by the USGS on groundwater quality and elevations over the past 25 years have been valuable in developing a conceptual model of the Snake River Plain Aquifer response to recharge from the spreading areas. Evaluation of the groundwater exposure pathway is the responsibility of the Groundwater Operable Unit (OU 7-02). The OU 7-08 Baseline Risk Assessment (BRA), however, requires data on the groundwater pathway. The VOC flux to the groundwater and the potential for ingestion of VOCs via this exposure route may be an important contributor to the potential for adverse health effects. Data from the groundwater (Snake River Plain Aquifer) investigation beginning in Fiscal Year 1992, will be used as requirements for the Operable Unit 7-08 BRA and the Focused RI/FS.

11. **Treatability Study.** The objectives of the Vapor Vacuum Extraction (VVE) treatability study are:

    - Demonstrate the viability of VVE as a remedial alternative for the vadose zone beneath the SDA
    - Optimize the VVE system performance and identify the optimum vertical zone of extraction
    - Provide design criteria and design data for probable VVE scale-up for long-term remediation

- Provide operation, maintenance, and capital costs

- Provide data on VOC transport in the vadose zone beneath the SDA

In pilot-scale studies, testing is usually limited to evaluating a few critical parameters with greater replication in order to optimize the technology's performance and test confidence. The pilot-scale VVE treatability study test design is based on a factorial design with two parameters and two operating levels. The two operating levels for the extraction zone parameter are high VOC concentration zone and high permeability zone. The two operating levels for the injection parameter are "on" and "off".

Within the VVE treatability study several tasks will be performed; however, they are components of the treatability study test design. Other tasks to be performed during the treatability study include tracer studies, off-gas treatment evaluation and operation, extraction well flow and pressure tests, installation of the injection well, installation of the monitor well and cold weather operation.

The following activities (VOC surface flux, soil moisture and soil gas survey) will only be done if the first phase of field activities and interpretation of those data determines that they are needed for the Baseline Risk Assessment to determine VOC being released to the air pathway.

12. **Soil-Gas Survey (contingent).** Near surface soil vapor samples will be collected using a vapor probe sampler. Section 2.4 of this SAP details the sampling frequency and locations. The vapor probes will be inserted into the ground surface to a maximum depth of 2.5 ft. Field screening with a portable volatile organic vapor analyzer will be used to optimize subsequent GC analysis of the soil gas and to determine whether the vapor probe will be left in the ground for subsequent sampling. If total VOC concentrations of >100 ppm are detected, the probe will be labeled and left in place. If <100 ppm, the location will be logged in the sampling logbook.

    Golder Associates performed a soil gas survey of the near surface (approximately 30 in. depth) surficial soil at the SDA during October 28 through November 6, 1987 (Golder, 1987). The survey covered all of the SDA and about 600 ft beyond the SDA fence. A total of 136 samples were collected on a grid of 200-ft spacing at a depth of approximately 30 in. The analysis results reported by Golder (1987) were those concentrations at or above the reporting limits. Levels above the reporting limit were found for four volatile organic compounds: carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene. The highest concentrations of the four organic compounds were found above burial pits.

The purpose of this contingent soil gas survey will be to determine the identity, location, and relative concentration of selected chlorinated VOCs in the vadose zone within the SDA at the same locations as the 1987 Golder study.

Soil gas will be extracted by driving a 5/8 in. OD steel probe approximately 30 in. into the ground using a slide hammer or a hand-held electric rotary hammer drill. Soil vapor is drawn from the ground through a flexible teflon tube inside the probe using an applied vacuum. The gas sample will be collected in a Tedlar bag. Analysis of soil gas samples for VOCs will be performed in a field laboratory with a field gas chromatograph (GC) calibrated for carbon tetrachloride, chloroform and trichloroethylene.

The proposed soil gas survey will reestablish the areal distribution of active VOC sources in the pits and trenches and will provide some relative measure of their strength. The survey will also determine whether significant changes in organic vapor concentrations have occurred and to further characterize the soil-gas distribution for the organic contamination in the vadose zone.

13. **VOC Surface Flux (Flux Chamber) (contingent).** The flux chamber is designed to measure the emission (flux) of VOCs from the ground surface. The flux chamber is an enclosure device that provides a defined surface area from which to sample. Clean, dry sweep air is added to the chamber at a fixed rate. The volumetric flow rate of air swept through the chamber is recorded and the concentration of VOCs is measured at the exit of the chamber using a Tedlar bag sample and portable GC. Data analysis assumes that the flux from the soil surface is completely mixed with the clean air passing through the chamber and that the chamber does not significantly influence the VOC flux rate from the surface. Flux measurements will be performed at eight locations in the SDA, encompassing a range of anticipated flux levels. A permeameter will be set up to measure surface soil permeability during the flux tests. The permeability of the soil surface is related to changes in diffusion coefficients induced by seasonal effects in soil moisture, soil conditions, and natural variation. These data will permit the determination of the mean emission rate for the SDA for use in the air pathway analysis and refine the source term model.

    VOCs enter the air pathway by diffusing across the soil surface or evaporating from contaminated soil transported to the soil surface. Knowing the VOC flux across the soil surface and having measured atmospheric stability parameters allows direct computation of exposure levels through the air pathway. Surface flux measurements are needed to provide VOC releases to the air and estimates of worker exposure to VOCs. The VOC surface flux is important in projecting the time variations of the VOC plume in the Vadose zone. The VOC flux across the soil surface will be estimated using a flux chamber. The purpose of this study is to estimate the flux during typical soil conditions (i.e. wet, dry, and frozen) while simultaneously estimating or measuring soil moisture content, surface permeability, and soil temperature.

Eight locations will be selected in the SDA for surface VOC flux measurements. These sites will be located based on the results from the soil gas surveys. Ideally, VOC flux estimates will be performed under 3 different soil conditions or seasons during the Remedial Investigation (RI) at each site to determine the effect of seasons and weather. The effect of soil surface temperature and soil moisture on the VOC flux will be estimated during the surface flux testing.

Soil surface temperature will be measured using a thermocouple on the soil surface (shaded from the sun and in the sun). Surface soil moisture content will be estimated using a surface moisture gauge. Surface permeability will be estimated using the air permeameter described by Tanner and Wengel (1957) and the data analysis method of Grover (1955). See Appendix E for calibration and experimental methodologies.

14. **Soil Moisture Measurements (contingent).** The task objective is to obtain the soil moisture profiles within surficial sediments from 18 locations within the SDA. Data will be collected on the soil moisture profiles on a periodic basis throughout the year to determine the potential infiltration rates, distribution of moisture content, and effective soil porosity within the SDA. These data will also be used in the organic transport models.

Fifteen holes will be drilled in the SDA around designated pits and trenches within the surficial sediments to a depth of the first basalt (not greater than 30 ft). In addition, three existing neutron probe access locations at the SDA will be used. Soil moisture content will be measured at 1-ft-depth intervals using a neutron probe (Campbell Pacific hydroprobe). Soil moisture will be measured monthly for 6 months. Soil moisture data will be used in conjunction with the VOC surface flux.

Soil moisture data has been previously collected inside the SDA and reported by Laney et. al. (1988) and McElroy (1990). Refer to Laney (1988) for a description of the project monitoring objectives and data collected.

The neutron probe measurements will be calibrated with conventional soil moisture measurements using core samples from selected neutron probe holes. Procedures for use of the Hydroprobe are presented in Hubbell, Hampton, and Hull (1988).

The neutron moisture gage measures the moisture content in the soil by supplying a source of fast neutrons which are slowed by the presence of hydrogen in water. The slow neutrons are detected and counted. This count can be correlated to moisture content. The data is presented as the count rate to examine relative changes in moisture content. Higher count rates correspond with higher moisture contents.

The access tubes are standard 1.5 in. Schedule 40 pipe. They are installed by hand auguring a hole, taking moisture samples at various depths, then pushing the access tubes into the ground. A steel pipe (access tube) will be placed in each hole immediately after coring to minimize soil moisture evaporation. The moisture samples are utilized to calibrate the instrument with the soils. Readings can be taken at any depth or time interval. The readings are taken by lowering the source down the access tubing and activating the counter on the gauge.

1.2 Project Organization and Responsibilities

Table 1-1 provides a list of key project personnel and responsibilities (also see Figure 1-4).

All field personnel will have received the required training prior to the start of field activities, to include the health and safety training required by the health and safety plan (EG&G Idaho 1992b). Lines of command and lines of communication are identified by the task organizational chart (see Figure 1-4). Field team leaders (FTL) will report to the project manager and coordinate on site activities with the job site supervisor.

Table 1-1. Key project personnel and responsibilities.

Personnel	Discipline/Tasks Assigned
G. E. Matthern	Task Project Manager
N. W. Spang	Task Project Engineer
T. B. Arrington	Task RWMC Technical Programs Field Office/Job Site Supervisor
D. L. Michael	Sampling Project Manager
W. C. Downs	Project Technical Leader
W.J. Isle	ERD Quality Engineer
A. J. Sondrup	FTL/Transport Modeling
R. M. Lugar	FTL/Data Evaluation
J. M. Hubbell	FTL/Geoscientist
K. Keck	Senior Scientist/Project Geologist
I. R. Anderson	FTL/Data Collection Technician/GC Operator/-Data Evaluation
K. Izbicki	FTL/Data Collection Technician/GC Operator/Data Evaluation
L. Lazzarotto	Data Collection Technician/GC Operator
K. J. Galloway	Data Collection Technician/GC Operator/Data Evaluation
R. J Mockli	Field Technician
D. K. Gray	RWMC Safety Engineer
D. S. Shoop	RWMC Industrial Hygienist/Health and Safety Officer (IH/HSO)
S. E. MacLeod	RWMC Radiological Engineer
S. B. French	RWMC Environmental Engineer
D. A. Schroder	RWMC Quality Engineer
M. K. Branter	WMD Health Physics Manager

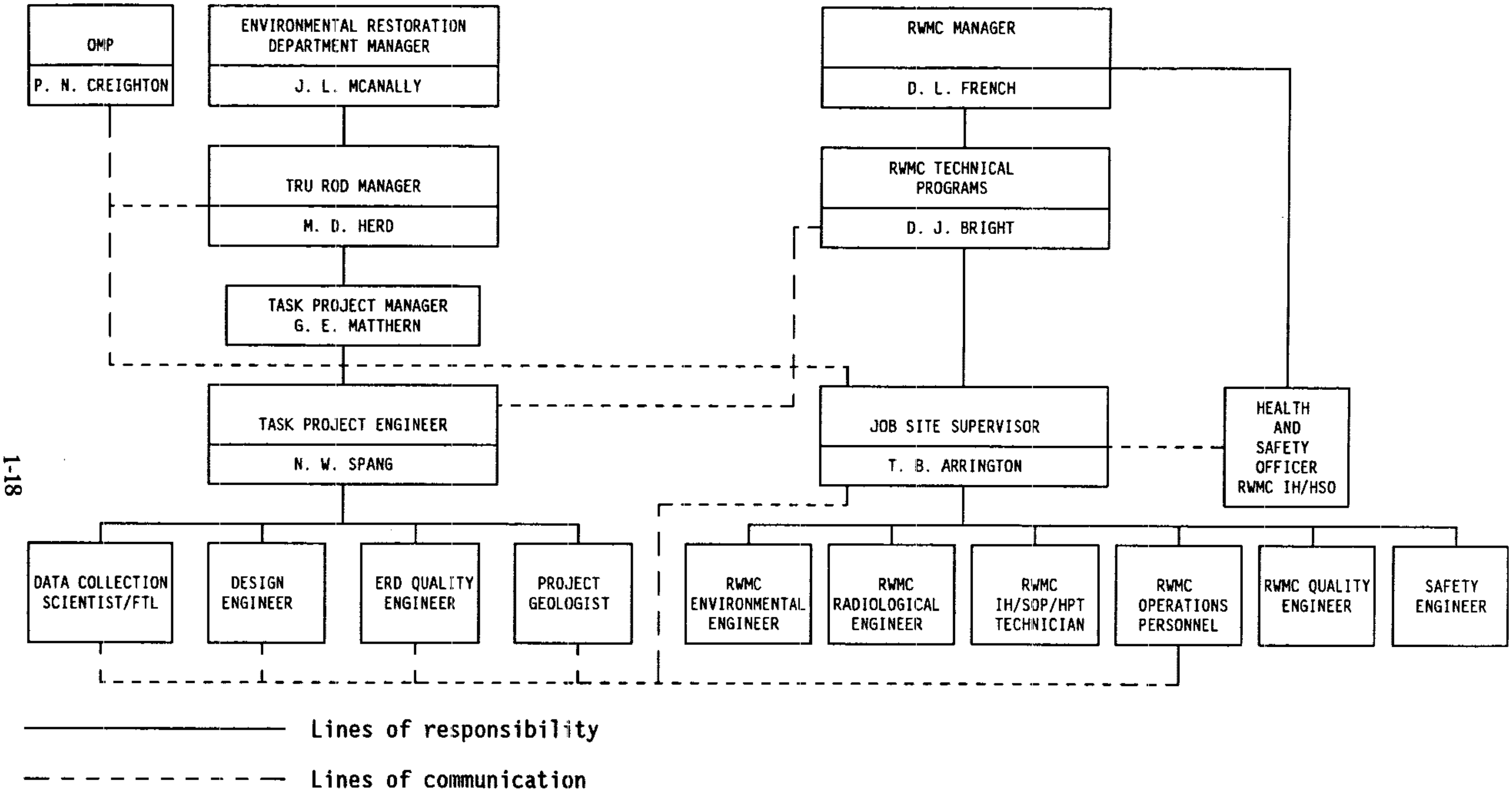


Figure 1-4. Task organizational chart for the Focussed RI/FS in the RWMC vadose zone.

1.3 Quality Assurance Objectives for Measurement

1.3.1 Data Quality Objectives

The data quality objectives for this project specify the quality of the data required to support decisions concerning remedial response. The data will be used to better define the nature and extent of the vapor plume and to develop the baseline risk assessment, which will ultimately influence the selection of an appropriate remedial response.

Section 5 of the Focused RI/FS Work Plan (EG&G Idaho 1992a) provides detailed information concerning the risk assessment process.

The portable GC used in tasks 1, 2, 5, 6, 9, 11, 12, and 13 will be targeting the following analytes for quantification:

- Carbon tetrachloride (CCl_4)
- Trichloroethylene (TCE)
- Chloroform ($HCCl_3$.)

Other compounds to be matched with GC library references include:

- Toluene
- 1,1,1 Trichloroethane
- Freon 113
- Perchloroethylene
- p-xylene
- m-xylene
- o-xylene
- trans 1,2 Dichloroethylene
- 1,1,2,2 Tetrachloroethylene.
- 1,1,2 trichloroethane
- Isooctane
- Carbondisulfide
- Acetone
- 1,1 Dichloroethylene
- Methyl ethyl ketone
- Methylene chloride
- Ethylbenzene
- Styrene

The GC will also be calibrated for sulfur hexafluoride (SF_6) during sampling tasks 10 and 12 vapor samples for off-site. Laboratory comparison/confirmation will be analyzed for VOCs specified in Table 1-3. Water samples will be analyzed for metals, anions, semi volatiles, and radionuclides as specified in Table 1-2. Validation procedures are described in Appendix 0.

Table 1-2 summarizes the data quality objectives for each field sampling/data gathering task. The detection limits stated for each task are determined so as to support the baseline risk assessment. Required detection limits for each analysis, by medium, are presented in Table 1-6.

Table 1-2. Data quality objectives summary.

Task (measurement)	Method	Analytical level	Data Validation level	Data uses	Precision	Accuracy	Detection limit	Critical Samples
1. Vapor Concentration/Soil Temperature[12]								
VOCs[9]	Portable GC (O&MM 9.8)	II	C	N&E, RA	± 10%	± 20%[1]	1 ppm (CCL_4)	None
	5% offsite via mod. EPA TO-14 or Mod. SW 846 method 8240/8260	V	A	M&E, RA	per lab SOW	per lab SOW	<500 ppb (CCl_4)	
Temperature	Sensor/data log	II	C	RA	± 2°C	± 2°C[2]	Not applicable (NA)	None
2. Vapor Port Monitoring[12]								
VOCs[9]	Portable GC (O&MM 9.8)	II	C	N&E, RA	± 10%	± 20%[1]	1 ppm (CCL_4)	1 from each of 6 wells
	5% off site via mod. EPA TO-14 or Mod. SW 846 method 8240/8260	V	A	N&E, RA	per lab SOW	per lab SOW	<500 ppb (CCL4)	
3. Perched Water[13]								
Water level	Electronic Sensor	II	C	N&E, RA	NA	± 0.1 ft[2]	0.01 ft	
Temperature	Hydrolab	II	C	N&E, RA	NA	± 0.15°[2]C	0.01°C	
Conductivity	Hydrolab	II	C	N&E, RA	NA	± 1% of range[2]	4 digits	
pH	Hydrolab	II	C	N&E, RA	NA	±0.1 pH unit[2]	0.01 units	
VOCs[8]	CLP Organics SOW (Cur. Rev.)	IV	A	N&E, RA	Per SOW	Per SOW	Per CLP SOW[3]	1 total
Metals[10]	CLP Inorganics SOW (Cur. Rev.)	III	A	N&E, RA	Per CLP SOW	Per CLP SOW	Per CLP SOW[5]	
Radionuclides[11]	Gamma spectrometric analysis RML	IV	C	N&E, RA	Per RML SOPs	Per RML SOP	Per RML SOP[4]	
Anions	EPA 300.0	III	C	N&E, RA	Per SOW	Per SOW	Per SOP	
Semi-Volatiles	CLP organics SOW (Cur. Rev.)							
Gross alpha/beta[11]	ERD SOW	IV	A	N&E, RA	Per RML SOPs	Per RML SOP	Per RML SOW[4]	
Isotopic specific[11]	ERD SOW							
4. Vapor Port Permeability[12]								
Vapor port pressure	Pressure transducer, DAS, flowmeter	II	C	RA	± 5 psi	± 1 psi[2]		None
		II	C	RA	± 20%	± 20%[2]		
5. Basalt Tracer Studies[12]								
Tracer concentration	Portable GC (O&MM 9.8)	II	C	RA	± 10%	± 20%[1]	1 ppm (SF_6)	None
Elapsed time								
Temperature	DAS Sensor	II	C	RA	± 1°C	± 1°C[4]	NA	

Table 1-2. Data quality objectives summary.

Task (measurement)	Method	Analytical level	Data Validation level	Data uses	Precision	Accuracy	Detection limit	Critical Samples
6. Downhole Barometric Pressure/VOC Concentration[12]								
Pressure	Pressure transducer	II	C	N&E, RA	± 10%	± 20%	N/A	
VOCs[9]	Portable GC (O&MM 9.8)	II	C	N&E, RA	± 10%	± 20%	1 ppm (CCl_4)	1 from each well
	5% offsite via Mod. EPA TO-14 or Mod. SW 846 method 8240/8260	V	A	N&E, RA	Per lab SOW	Per lab SOW	<500 ppb (CCl_4)	
7. Meteorological Data								
Wind speed	Anemometer	II	C	APA,RA	NA	NA	0.1 mph	NA
Direction	Vane	II	C	APA,RA	NA	NA	1°	
Barometric Pressure	Barometer	II	C	APA,RA	±1 torr	±1 torr	1 torr	
Temperature	Sensor	II	C	APA,RA	± 1°F	± 1°F	0.1°	
8. Stratigraphy and Structural Geology	Data survey	NA		NA	NA	NA	NA	NA
9. Open Well Vapor Sampling a. Well Gas Sampling[12]								
VOCs[9]	Portable GC (O&MM 9.8)	II	C	N&E, RA	±10%	±20%[1]	1 ppm (CCl_4)	1 from each well
	5% offsite via Mod. EPA TO-14 or Mod. SW 846 method 8240/8260	V	A	N&E, RA	Per lab SOW	Per lab SOW	<500 ppb (CCl_4)	
b. Shallow Well Screening[12]								
VOCs[9]	Portable GC (O&MM 9.8)	II	C	N&E, RA	±10%	±20%	1 ppp (CCl_4)	1 from each well
10. Groundwater Quality and Elevation[13]	Groundwater OU 7-06 evaluation of data	NA		NA	NA	NA	NA	GW-SAP

Table 1-2. Data quality objectives summary.

Task (measurement)	Method	Analytical level	Data Validation level	Data uses	Precision	Accuracy	Detection limit	Critical Samples
11. Treatability Study[12]								
VOCs[9]	Portable GC (O&MM 9.8)	II	C	RD	± 10%	± 20%	1 ppm (CCL_4)	TS Work Plan
12. Soil-Gas Survey (Contingent)[12]								
VOCs[9]	Vapor Probe sampler Portable GC (O&MM 9.8)	II	C	APA,N&E,S TM	± 10%	± 20%	1 ppm (CCL_4)	TBS if completed
13. VOC Surface Flux (Flux Chamber) (Contingent)[12]								
VOCs[9]	Flux chamber (EPA/600/8-86/008)	II	C	APA	± 10%	± 20%[1]	1 ppm (CCL_4)	TBS if completed
Sweep air flow rate	Portable GC (O&MM 9.8) Flowmeter	II	C	APA	± 20%	± 20%[2]	0.5 L/minute	
Meteorological data	NOAA, USGS, EG&G	II	C	APA	See Sec. 2.5.2.13	See Section 2.5.2.13	See Section 2.5.2.13	N/A
Vapor temperature	K-type thermocouple	II	C	APA	± 1°C	± 1°C[2]	0.5°C	
Surface permeability	Permeameter/flowmeter	NA		TM	± 20%	NA	NA	
Emission rate	Calculated	II	C	APA	± 10%	± 50% (per EPA)	1 μg/min•m^2	
14. Soil Moisture (Contingent)	Field soil moisture meter	NA		TM	± 1% volume	± 2% by volume	2% moisture content	TBS if completed

Table 1-2. Data quality objectives summary.

Task (measurement)	Method	Analytical level	Data Validation level	Data uses	Precision	Accuracy	Detection limit	Critical Samples

APA	-	air pathway analysis
N&E	-	nature and extent of contamination
TBS	-	To be specified
GW	-	Groundwater
NA	-	not applicable
RA	-	risk assessment
RD	-	remedial design

1. Percent of known reference value
2. Variation from calibration value
3. CLP SOW for Organics - (current revision) (Appendix N)
4. EG&G-ID Internal Technical Report ST-CS-DV3-89, May 1989 (Appendix O)
5. CLP SOW for Inorganics - 2/89, 6/89 (current revision) (Appendix N)
6. Data Quality Objectives for Remedial Response Activities Development Process, NTIS PB88-131370
7. SOPs for Data Validation (Appendix O)
8. Refer to Table 1-4 for target analyte list of volatile organic compounds for water samples
9. Refer to Table 1-4 for target analyte list of volatile organic compounds for verification gas samples
10. Refer to Table 1-5 for target and analyte list of organic compounds for water samples
11. Refer to Table 1-6 and 1-7 for target analyte lists of radionuclides for water samples
12. Medium is gas
13. Medium is water

Table 1-3. Target analyte list and detection limits for soil gas verification samples.

Volatiles	Detection Limit [a] (ppmv)	MDL (ng)
1. Acetone	25	150[b]
2. Benzene	1	8
3. Bromoform	1	8
4. 2-Butanone	25	150[b]
5. Chloroform	1	8
6. Carbon Tetrachloride	1	8
7. Chlorobenzene	1	8
8. 1,1-Dichloroethane	1	8
9. 1,2-Dichloroethane	1	8
10. 1,1-Dichloroethene	1	8
11. Ethylbenzene	1	8
12. Methylene Chloride	1	8
13. 4-Methyl-2-pentanone	25	150[b]
14. 1,1,2,2-Tetrachloroethane	1	8
15. Tetrachloroethene	1	8
16. Toluene	1	8
17. 1,1,1-Trichloroethane	1	8
18. Trichloroethene	1	8
19. 1,1,2-Trichlorotrifluoroethane	1	8
20. Xylene (meta & para)	1	8
21. Xylene (ortho)	1	8

a = The PRQL levels assume that 10mls is delivered to the analytical system.

b = Estimate, to be determined

Table 1-4. Target analyte list and detection limits for volatile organic compounds in water samples.

Compound	CAS Number	Detection Limits[1] Water ug/L	On Column (ng)
1. Chloromethane	74-87-3	10	(50)
2. Bromomethane	74-83-9	10	(50)
3. Vinyl Chloride	75-01-4	10	(50)
4. Chloroethane	75-00-3	10	(50)
5. Methylene Chloride	75-09-2	10	(50)
6. Acetone	67-64-1	10	(50)
7. Carbon Disulfide	75-15-0	10	(50)
8. 1,1-Dichloroethene	75-35-4	10	(50)
9. 1,1-Dichloroethane	75-34-3	10	(50)
10. 1,2-Dichloroethene	540-59-0	10	(50)
11. Chloroform	67-66-3	10	(50)
12. 1,2-Dichloroethane	107-06-2	10	(50)
13. 2-Butanone	78-93-3	10	(50)
14. 1,1,1-Trichloroethane	71-55-6	10	(50)
15. Carbon Tetrachloride	56-23-5	10	(50)
16. Bromodichloromethane	75-27-4	10	(50)
17. 1,2-Dichloropropane	78-87-5	10	(50)
18. cis-1,3-Dichloropropene	10061-01-5	10	(50)
19. Trichloroethene	79-01-6	10	(50)
20. Dibromochloromethane	124-48-1	10	(50)
21. 1,1,2-Trichloroethene	79-00-5	10	(50)
22. Benzene	71-43-2	10	(50)
23. trans-1,3-Dichloropropene	10061-02-6	10	(50)
24. Bromoform	75-25-2	10	(50)
25. 4-Methyl-2-pentanone	108-10-1	10	(50)
26. 2-Hexanone	591-78-6	10	(50)
27. Tetrachloroethene	127-18-4	10	(50)
28. Toluene	108-88-3	10	(50)
29. 1,1,2,2-Tetrachloroethane	79-34-5	10	(50)
30. Chlorobenzene	108-90-7	10	(50)
31. Ethyl Benzene	100-41-4	10	(50)
32. Styrene	100-42-5	10	(50)
33. Xylenes (Total)	1330-20-7	10	(50)

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1. Quantitative limits (CQR - contract required quantitative limits) are matrix dependent.

Table 1-5. Target analyte list and detection limits for inorganics for water samples.

CAS #	Compound	Detection Limits[a] Water (ug/1)
7429-90-5	Aluminum	200
7440-36-0	Antimony	60
7440-38-2	Arsenic	10
7440-39-3	Barium	200
7440-41-7	Beryllium	5
7440-43-9	Cadmium	5
7440-70-2	Calcium	5000
7440-47-3	Chromium	10
7440-48-4	Cobalt	50
7440-50-8	Copper	25
7439-89-6	Iron	100
7439-92-1	Lead	5000
7439-95-4	Magnesium	15
7439-96-5	Manganese	0.2
7439-97-6	Mercury	40
7440-02-0	Nickel	5000
7440-09-7	Potassium	5
7782-49-2	Selenium	10
7440-22-4	Silver	5000
7440-23-5	Sodium	10
7440-28-0	Thallium	50
7440-66-6	Zinc	20

a. Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Table 1-6. Target analyte list and detection limits by gamma spectrometry for environmental 540 ml water samples[a,b]

Radionuclide	pCi/ml	Radionuclide	pCi/ml
Na-22	1.0E-2	Ce-144	7E-2
Al-26	1.0E-2	Eu-152	3E-2
K-40	2E-1	Eu-154	4E-2
Sc-46	2E-2	Eu-155	4E-2
Cr-51	8E-2	Hf-181	2E-2
Mn-54	1.0E-2	Ta-182	5E-2
Co-58	1.0E-2	Hg-203	1.0E-2
Fe-59	2E-2	ThTl-232	1.6E-1
Co-60	2E-2	ThPb-232	4E-2
Nn-65	3E-2	ThBi-232	2E-1
Nb-94	1.0E-2	ThRa-232	4E-1
Zr-95	2E-2	ThAc-232	8E-2
Nb-95	1.0E-2	Ra-226	2E-1
Ru-103	1.0E-2	RaPb-226	2E-1
RuRh-106	1.0E-1	RaBi-226	2E-1
Agm-108	1.0E-2	U-232	1.1E+1
Agm-110	1.0E-2	U-234	4.3E+1
Sb-124	1.0E-2	Th-234	5E-1
Sb-125	4E-2	Pa-234	2.3E+0
Cs-134	1.0E-2	U-235	7E-2
Cs-137	3E-2	Pu-239	1.0E+2
		Am-241	5E-2

Sample Description

Matrix: Water
Volume: 540 ml
Count Time: 16 hours
Geometry: 540 ml poly bottle
Mass: N/A

NOTE 1 The detection limits for given radionuclides will vary from sample to sample due to the radionuclide mixture and concentrations in the sample. Other parameters affecting the detection limits can be the sample matrix, sample geometry, counting times and the detector system used.

NOTE 2 The detection limits for the Radon/Thoron daughters were determined at or near equilibrium and should only be applied under these conditions.

a. Reference: Radiation Measurements Laboratory

b. If a smaller sample is analyzed the detection limits may be higher.

Table 1-7. Target analyte list and detection limits for isotope specific alpha spectrometry

Element	Isotope	Detection Limit
Plutonium	Pu^{238},$Pu^{239/240}$	0.2 pCi/l
Uranium	$U^{234,235,238}$	0.5 pCi/l
Americium	Am^{241}	0.2 pCi/l

a. Based on 100 mls of water sample. If a smaller volume is analyzed the detection limits may be higher.

b. Isotope specific analysis will be done if gross alpha/beta analysis of sample reflects > 10 pCi/l.

c. Reference: ERD SMO SOW-33

Table 1-8. Risk based detection limits.

Analyte	Medium	Risk-Based Detection Limit	Practical Quantitation Limits
CCl_4	Air	3 mg/m^{3a}	3.15 mg/m^{3c}
	Water (perched/aquifer)	0.3 μg/l^{b}	
	Soil	5 mg/kg^{b}	
TCE	Air	27 mg/m^{3a}	5.36 mg/m^{3c}
	Water (perched/aquifer)	3 μg/l^{b}	
	Soil	60 mg/kg^{b}	
Chloroform	Air	5 mg/m^{3a}	4.87 mg/m^{3c}
	Soil	100 mg/kg^{b}	
	Water (perched/aquifer)	0.3 μg/l^{b}	
Tetrachloroethylene	Air	34 mg/m^{3a}	6.7 mg/m^{3c}
	Water (perched/aquifer)	1 μg/l^{b}	
	Soil	10 mg/kg^{b}	
1,1-Dichloroethylene	Air	2 mg/m^{3a}	3.96 mg/m^{3c}
	Water (perched/aquifer)	.07 μg/l^{b}	
	Soil	1 mg/kg^{b}	
1,1,2,2-Tetrachloroethane	Air	0.7 mg/m^{3a}	6.93 mg/m^{3c}
	Water (perched/aquifer)	.09 μg/l^{b}	
	Soil	3 mg/kg^{b}	
1,2-Dichloropropane	Air	35 mg/m^{3a}	4.48 mg/m^{3c}
	Water (perched/aquifer)	1 μg/l^{b}	
	Soil	9 mg/kg^{b}	

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a. 10% of TLV-TWA (Threshold Limit Values - time weighted average), *Threshold Limit Values and Biological Exposure Studies for 1988-1989*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1988.

b. EPA Region 10 "Supplemental Risk Assessment Guidance for Superfund," August 16, 1991.

c. Based on the injection of 10 ml samples during analysis.

1.3.2 Precision

Precision is a measure of mutual agreement among individual measurements of the same property, under identical conditions. Precision is assessed by means of laboratory duplicate/field replicate sample analysis. At the offsite laboratory, the objective for precision is to equal or exceed blanks and field standards (blind) will be shipped with regular vapor samples to be analyzed by the offsite laboratory.the precision demonstrated for similar samples and shall be within the established control limits for the CLP methods and SW-846 (EPA 1986a) methods.

1.3.2.1 Field Precision. Field precision will be calculated using results of co-located field sample duplicates or measurements as both the standard deviation and the percent relative standard deviation (% RSD). Precision is either expressed as the RPD for duplicate measurements or as the RSD for three or more replicate measurements. The standard deviation, s, is calculated from the variance, s^2, as

$$s^2 = \frac{\Sigma\left(x_i - \bar{x}\right)^2}{n - 1}$$

and

$$s = \sqrt{s^2} \quad .$$

The % RSD is then

$$\% \text{ RSD} = s/\bar{x} \quad *100$$

The standard deviation and % RSD are calculated for every replicate/duplicate measurement or sample analysis.

For duplicate measurements, the precision expressed as the RPD is calculated as shown below:

$$RPD = \frac{C_1 - C_2}{(C_1 + C_2)/2} * 100$$

C_1 and C_2 are the two values obtained from the analysis of the duplicate samples. C_1 is the larger of the two observed values.

The frequency of measurement and sample collection duplication will be incorporated into the individual task procedure. Results of duplicate measurements blanks and standards analyses will be used to create control charts for long-term monitoring of precision on the portable GC.

See Table 1-2 for task-specific precision requirements.

1.3.2.2 Laboratory Precision. Laboratory precision will be evaluated through the use of matrix spikes (MS) and matrix spike duplicates (MSD) for organic analyses and laboratory duplicates for inorganic and radiochemical analyses. Precision will be calculated as relative percent difference (RPD) for duplicate measurements. Percent relative standard deviation (%RSD) calculations shall be used for the assessment of precision on three or more replicate measurements. Regarding the Level V VOC analysis of gas samples, a laboratory control sample (LCS) and an LCS duplicate (LCSD) shall be used to assess precision.

1.3.3 Accuracy

Accuracy means the nearness of a result, or the mean of a set of results, to the true value. Accuracy is assessed by means of reference samples and percent recoveries.

1.3.3.1 Field Accuracy. Determining whether a sample will yield results that accurately reflect the true concentration of a contaminant in the soil, sediment, or groundwater cannot be quantitatively assessed. However, the sampling locations and methods described in this plan have been chosen to be representative of the media being sampled. The field accuracy objective for field GC analysis is for the measured value to be within ± 20% of the "true value," based on a known standard. See Table 1-2 for task-specific accuracy goals.

Cross-contamination of the samples would yield inaccurate results. Therefore, equipment rinsates (perched water samples only) to determine the thoroughness of cross-contamination control and field blanks to measure background will be sent to laboratories for chemical and radiological analysis. Trip

1.3.3.2 Laboratory Accuracy. The quality assurance project plan and standard operating procedures (SOPs) of radiological and analytical laboratories will describe procedures to evaluate laboratory accuracy. Laboratory accuracy will be used to help determine if the laboratory is in control and assign uncertainties to the data.

Accuracy of the offsite chemical laboratory data will be assessed through the calculation of percent recovery from MS/MSD analysis and any in-house or blind certified standards that the laboratory analyzes as part of its ongoing quality assurance/quality control (QA/QC) program.

Accuracy is expressed as the percent recovery (%R).

For measurements where standard reference material is used, the percent recovery (%R) is calculated as shown below:

$$\%R=\frac{C_m}{C_{srm}}*100$$

C_m is the measured concentration value obtained by analyzing the sample, and C_{srm} is the "true" or certified concentration of the analyte in the sample.

For measurements where matrix spikes are used, the %R is calculated as shown below:

$$\%R=\frac{S-U}{C_{sa}}*100$$

S is the measured concentration in the spiked aliquot, U is the measured concentration in the unspiked aliquot, and C_{sa} is the actual concentration of the spike added.

The laboratory is also required by the laboratory SOW to run a sufficient number and type of blanks to detect laboratory contamination.

1.3.4 Radiological Laboratory Precision and Accuracy

For radiological analyses, uncertainties traditionally have not been broken down into precision and accuracy components. Instead, either a statistical uncertainty, based on Poisson statistics of radioactive emissions, and/or a total uncertainty, in which other error components are combined with the statistical uncertainty by adding in quadrature, is reported. The statistical component is a function of the number of counts in the peak. Because the decay of radioactive elements is subject to Poisson statistics, the statistical uncertainty is equal to the square root of the number of counts in the peak. For gamma spectrometry, where peak-fitting programs are used to quantify the peak area, the statistical uncertainty is dependent on the peak-fitting routine. Other components added may be uncertainties from the chemical procedure, if any, or uncertainties in the efficiency of the detector or geometry of the sample. A variety of other uncertainties may be included in efficiency or geometry uncertainties, or may be added separately. Because of cascade summing effects of some gamma decays, uncertainties may be higher for samples containing more than one radionuclide or for samples not in the exact geometry for which the detector has been calibrated.

Results of radiological analyses are very dependent on the geometry and matrix of the sample. If these are not as specified, both the detection limits and range of uncertainties may change in ways that can only be determined by an experienced analyst. An experienced analyst should always be consulted for each individual analysis to resolve these and other questions.

1.3.5 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. The representativeness criterion is best satisfied by making certain that sampling locations and methods are selected and documented properly and that a sufficient number of samples are collected. Documentation requirements are profiled in Section 2.6.3 of this plan. Table 1-2 states the requirements for completion.

Representativeness of the extent of contamination in the vadose zone vapor plume is limited by the location and depth of existing open wells and installation of six new wells. DOE, IDHW, and EPA conducted scoping meetings and used available data in an effort to optimize the sampling activities required to characterize the contamination in the vadose zone beneath the SDA.

1.3.6 Completeness

So that a set of data can be used with confidence in assessing potential exposure to hazardous substances of a site or facility with applicable procedures, the data must be complete (i.e., there must be enough valid data from analyses to make the assessment). An integral part of obtaining valid data is to design the sampling network in a manner that provides the minimum data necessary for site characterization, and identifies critical samples. Completeness for the project will be determined by the following calculation:

%C = V/N x 100

where

V = number of analytical results obtained (data points)

N = total number of determinations planned

Completeness for this project will be assessed by comparing the number of samples collected to the number of samples planned. The objective for completeness is that the investigation provides enough planned data so that the objectives of the project are met. The overall completeness goals for all parameters for the OCVZ Focused RI/FS sampling and analysis are 80% for sampling, and 85% for analysis (EG&G Idaho, 1991). Completeness will be calculated following data validation and reduction.

Critical samples are the minimum required to support the project objectives (Section 1.1.1) of this Focused RI/FS. A 100% completeness goal is required for the critical samples listed below:

- vapor samples below the 240-ft interbed (at least one sample from each of six groundwater/vapor monitoring wells outside the SDA)
- vapor samples just above the 110-ft interbed from six new wells outside the SDA (at least one sample from each of six groundwater/vapor monitoring wells outside the SDA)
- at least one perched water sample for volatile organic analysis
- deepest vapor port samples from existing six monitoring wells. (6 total)

1.3.7 Comparability

Comparability is used to express the confidence with which one set of data can be compared with another set of data. To assist in comparing data, all chemical analyses will be accomplished using an EPA or equivalent method. EPA-accepted methods for offsite chemical analyses are found in Table 1-2. Certain physical properties of the vadose zone soils and basalt will be measured using appropriate industry-accepted methods and equipment in accordance with documented procedures. All analytical results and field measurements will be reported in the concentration values and units required for entry into the Environmental Restoration Information System (ERIS) data base and those values and units needed for use in source term, transport, and risk assessment models. In order for data from subsequent sampling at the same site or facility to be compared, the specific sampling points will be established in relation to permanent reference points and documented.

Comparability will be assessed by comparing the following information on each data set:

- Field collection methods

- Field and laboratory quality assurance/quality control (QA/QC) procedures [in accordance with QPP-149 (EG&G Idaho 1991a)]

- Laboratory detection limits

- Matrix

- Relative percent difference (RPD) between portable QC results and offsite analytical laboratory results.

1.4 Sampling Procedures

Refer to the field sampling plan (Section 2 of this plan) for a discussion of field sampling procedures.

1.5 Sample Custody

Sample custody procedures shall be performed in accordance with ERD Program Directive (PD) 5.7, "Chain of Custody Record," for samples going to an ERD-approved offsite laboratory. Chain-of-custody documentation will not be used for vapor samples analyzed at RWMC, because the samples are to be collected and analyzed by the same field team.

The logbook will be used to record information required to verify the custody of onsite sample movement. Sample labels will contain the following information, at a minimum:

- Sample identification number
- Site name
- Date
- Time
- Analysis required
- Sampler's initials
- Special handling requirements
- Radiological readings (hand-held instrumentation, water samples only).

Details concerning sample handling for samples going to an offsite laboratory are outlined in QPP-149, Section 7 (EG&G Idaho 1991a).

1.6 Calibration Procedures

Each piece of equipment shall be identified so that calibration and maintenance can be tracked. The equipment shall have an individual calibration log and be calibrated/standardized prior to use or as part of the operational use following the manufacturer's recommended procedures and the procedures detailed in this section.

Measuring and test equipment shall be calibrated at prescribed intervals and/or prior to use. Frequency shall be based upon the type of equipment, inherent stability, manufacturer's recommendations, intended use, and experience.

1.6.1 On-Site Gas Chromatograph Calibration/Quality Assurance

The following vapor analysis QA data will be collected to estimate data quality and to determine the need for any corrective action in the event that the data do not meet the program's data quality objectives. This QA scheme has been used previously for the vapor vacuum extraction (VVE) demonstration project, so sample results will remain comparable.

GCs will be calibrated with a multi-component certified standard gas. If two GCs are calibrated, one will be calibrated to analyze samples that have a concentration greater than approximately 200 ppm total volatiles and the other calibrated to analyze samples that have a concentration less than approximately 200 ppm total volatiles. Multi-point calibration will be made on each GC throughout the day. All other aspects of GC operation will be performed according to the equipment-specific manufacturer's operating and maintenance manual and the *RWMC Operating and Maintenance Manual* (O&MM).

1. Before initial sample analyses, the portable GCs will be calibrated to a multi-component (CCl_4, TCE, $CHCl_3$) certified standard gas. Next, a field standard will be prepared using a manufacturer-certified gas standard. (Certifications will be kept on file in the GC calibration logbook.) Field standards will be prepared by diluting one of the certifiable standards within a Tedlar[a] sample bag. The field standard concentration will be selected based on the discretion of the GC operator. Appendix A, Environmental Technology Standard Operating Procedure 57 (ETSOP-57), contains specific procedures for performing dilutions. After analyzing the field standard, at least one room blank will be analyzed. A room blank will be analyzed at the end of the working day, or more often as determined by the operator.

2. A field standard (check) sample will be analyzed after every five regular samples to provide an ongoing check of the calibration stability of the instrument and to identify any deviation in instrument accuracy greater than ±20%. In the event that the instrument is out of this control tolerance limit, the field standard sample will be reanalyzed. If the instrument still demonstrates unacceptable accuracy, the operator will cease further analysis of regular samples until the instrument is brought back within the accuracy control limits. In this case, the operator is responsible for taking corrective action (see Section 1.13), which may include

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[a] Mention of specific products and/or manufacturers in this document implies neither endorsement or preference, nor disapproval by the U.S. Government, any of its agencies, or EG&G Idaho of the use of specific product for any purpose.

analyzing a room air blank to identify column/detector contamination, recalibrating, rebooting the GC operating software, refill of the field standard sample bag with fresh standard, leak checks, column bakeout, etc.

3. A minimum of one sample (from the same sample bag) will be re-analyzed once per every 10 samples to provide duplicates for repeatability (precision) assessment. If the operator notes a difference greater than ±10% between these two measurements, the sample will be analyzed a third time. If the third analysis is >±10%, corrective action (Section 1.13 of this SAP) will be initiated.

4. One set of co-located samples will be collected every 20 samples and submitted blind to the GC operator. The precision goal for these replicates samples is ±20%. If the operator notes results outside this limit, a duplicate analysis (same bag reanalyzed) will be performed on the co-located samples. If results are still outside the limits, the operator is responsible for taking the necessary corrective action before proceeding with further sampling and analyses of samples from that well. (See Section 1.13 for corrective action.) A third co-located sample may be collected and analyzed from the port demonstrating variable results. Co-located samples analyzed onsite. Off-site confirmatory analysis will be submitted "blind" to the onsite GC operator and off-site laboratory.

5. All maintenance and calibration actions taken will be logged in the field instrument calibration/standardization logbook for the GCs.

1.6.2 Field Instruments Calibration

The field instruments, including the soil moisture meter, DASs, pressure transducers, thermistors, flowmeters, permeameters, VOC monitor, etc. will be standardized and/or calibrated in accordance with the manufacturer's procedures applicable to the activity. If applicable, the frequency of standardization will be instrument-dependent. The instruments will also be restandardized/recalibrated if they are dropped, strained, or subjected to any other unusual stress. Meteorological instruments will be calibrated by either the USGS or National Oceanic and Atmospheric Administration in accordance with the manufacturer's instructions; typically at least once per year. If an instrument is affected by weather, the limitations will be noted prior to using the instrument.

1.6.3 Radiological Instrumentation Calibration

Radiological instrumentation shall be maintained and calibrated in accordance with the *EG&G Idaho Radiological Controls Manual* and applicable RWMC procedures.

1.6.4 Off-Site Analytical Calibration

Calibration procedures and documentation for all off-site analyses (radiological and chemical) are specified in laboratory SOPs, the laboratory Statement of Work, and EPA Methods.

1.6.5 Calibration Records

Records shall be prepared and maintained for each piece of calibrated equipment to indicate that established calibration procedures have been followed. Calibration records for the equipment controlled by the various laboratories, offices, and groups shall be maintained by the respective organizations during sampling. A copy of the instrument calibration logbooks for field instruments and portable GC shall be provided to the field team leader (FTL) weekly to indicate calibration status when the samples were being analyzed. The GC calibration records are part of the computer-logged information recorded during routine operation and therefore do not require a separate instrument calibration logbook. The GC operator's log also provides a hard copy record of GC calibrations. Any necessary deviations from the specification will be documented, dated, and signed. At the end of the project, all records will be forwarded to ERD Administrative Records and Document Control (ARDC) for final disposition.

1.6.6 Calibration Failure

Field and laboratory equipment found to be out of calibration shall be recalibrated in accordance with the requirements of this section and Section 1.13. The FTL will be notified immediately when test equipment is found to be out of calibration, damaged, lost, or stolen, and an evaluation shall be made to ascertain the validity of previous inspection or test results and the acceptability of components inspected and/or tested since the last calibration check. When it is necessary to ensure the acceptability of suspect items, the originally required inspections and/or tests shall be repeated using properly calibrated equipment. Suspect results for which a questionable device was used shall be listed in a nonconformance report or deficiency notice and forwarded to the ERD quality engineer with an information copy to the FTL. Test equipment consistently found to be out of calibration shall be repaired or replaced. Inspection and test reports shall include identification of the test equipment used to perform the inspection or test.

1.7 Analytical Procedures

Procedures for analysis of subsurface vapor samples by the portable GCs (located in WMF-729) are detailed in the equipment-specific manufacturer's operating and maintenance manual and RWMC O&MM 9.8. Vapor samples to be analyzed by the verification analytical laboratory will be analyzed in accordance with ERD SMO SOW (in preparation) using the methods specified in Table 1-2. Procedures for collecting other field measurement data are detailed in the specific SOP for that measurement. Perched water samples will be analyzed using methods specified in Table 1-2 according to the protocal specified in the organic ERD SMO SOW (ERP-SOW-47) and inorganic ERD SMO SOW (ERP-SOW-59). These analyses are analytical level III. Radiological (gamma) screening of the perched water samples will be performed by the EG&G Idaho Radiation Measurements Laboratory (RML) in accordance with Data Management 11, "RML Gamma Ray Analysis Report of Low-Activity-Level Water Samples." Specific samples designated for off-site analyses are listed in Table 2-2 and include analyses to be performed for each medium.

1.8 Data Reduction, Validation, and Reporting

1.8.1 Data Reduction and Reporting

Data reduction refers to computations and calculations performed on the data. This includes computing summary statistics, standard errors, confidence limits, tests of hypothesis relative to the parameters, and model validation. Standard equations and statistically acceptable procedures will be used. When appropriate, as determined by the analytical level, data will be reported with statistically supported limits of uncertainty to indicate limitations on the use of the data (see Table 1-2). All data, when reported, will be rounded to the number of significant figures consistent with the confidence limits.

Laboratory data reduction for samples sent offsite for analysis will be addressed in the SOW issued to analytical laboratories by EG&G Idaho. All bench chemists will document sample preparation activities in a bound laboratory notebook, which will serve as the primary record for subsequent data reduction. Final data reduction of analyses performed will be the responsibility of the individual compiling the final report. Results from each data collection activity will be reported in consistent units throughout each task. When applicable, as when presenting data on contaminant concentrations, any applicable State or Federal regulatory limits will be presented with the analytical data.

Laboratory data reporting will follow the procedures and format specified in the SOW for that laboratory. Results and QC data for each analysis will be transcribed onto analytical reporting forms specific to the particular analysis. These forms will be provided in the analytical SOW. All data will be checked for accuracy and precision at the bench and instrument operator/analyst level and at the laboratory manager's level before the data package is submitted to EG&G Idaho.

1.8.2 Method Data Validation

Data verification and method data validation including uncertainty calculations are the processes by which a sample measurement, method, or piece of data is deemed useful for a specified purpose. EPA functional guidelines will be followed for chemical analyses method validation. The data reporting forms will be reviewed as part of the data validation process to verify that the proper information is complete and correct. Data validation levels are indicated for each analysis in Table 1-2. SOPs for data validation are provided in Appendix O.

Data obtained from the portable GC and other field measurements will be validated to Level C. Level C method validation ensures that the data have been checked so that the value returned from the laboratory or field instrument is the value that is input into the ERIS (i.e., transcription error checking). The data package will be checked for completeness and any deficiencies will be resolved. The project manager is responsible for ensuring that these checks are completed. Figure 1-5 shows the data flow for the onsite analysis portion of this sampling activity. In addition to the data package completeness check and data entry into the ERIS, the following will be checked, at a minimum:

- Chain of custody
- Requested versus reported analyses
- Analysis holding times.

All of the procedures used for the data entry and automated method data validation steps that are performed by Integrated Environmental Data Management System personnel are described in EG&G Idaho Data Applications Unit operating procedures. The product of the Level C method data validation is upload of results to the ERIS.

Data obtained from the radiological and offsite chemical laboratories will be validated to Level A by the ERD SMO or their designated sub-contractor. Level A method data validation is the maximum effort for chemical analysis method validation (i.e., complete review of the raw data for a given sample analysis), and is CLP-equivalent.

Validation that data quality objectives have been successfully fulfilled will also be performed by the project manager or designee. Data flow for offsite analytical data will be as stated in ERD PD 2.4, "Characterization Process in the Environmental Restoration Department," Appendix A. All analyses will be validated to the appropriate designated level.

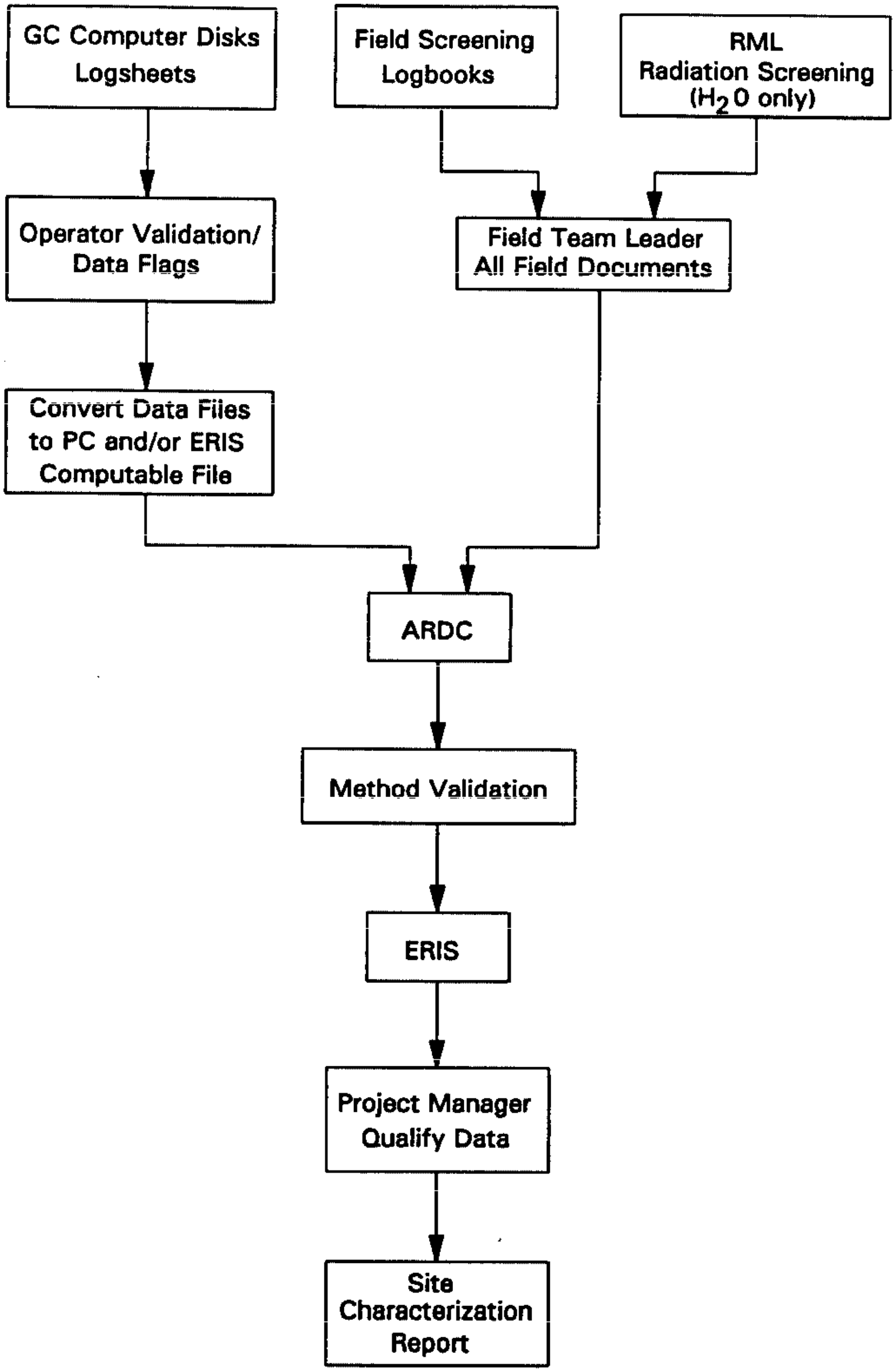

Figure 1-5. Data flow diagram for GC (onsite), and radiological screening/field screening.

1.9 Internal Quality Control

Internal QC will be performed in accordance with ERD QPP-149, Section 11 (EG&G Idaho 1991a) except where deviations are stated in this SAP and as approved by the project quality engineer or designated alternative (i.e., RWMC quality engineer). Document review will be performed on all documents per ERD PD 2.2, "Internal and Independent Review of Documents." Laboratory QC samples and laboratory control charts will be processed as required by the laboratory SOW. Field QC samples will include trip blanks and field standards.

1.10 Performance and Systems Audits

Normally, at least one performance assessment will be conducted by the ERD QA officer during sampling efforts. The project manager or FTL will notify the QA officer of the start date of the sampling activities at least 2 weeks in advance so that the assessment can be scheduled and a checklist can be prepared. All assessment activities will be performed in accordance with guidance from the assessment requirements of QPP-149, Section 12 (EG&G Idaho 1990c) except where deviations are stated in this SAP and as approved by the project quality engineer. All analytical support laboratories must be ERD approved.

1.11 Preventative Maintenance

All preventative maintenance will be performed according to the manufacturer's operating and maintenance manual or SOP for each piece of equipment used. All maintenance will be recorded in the instrument calibration logbooks, as required by ERD PD 4.2, "Logbooks." Laboratories shall provide for appropriate preventative maintenance practices in their internal quality assurance documents.

1.12 Data Assessment Procedures

The data will be used to (a) assess the nature and extent of the vapor plume in the RWMC vadose zone, (b) refine the vapor transport model, (c) estimate worker exposure to VOCs under a wide range of atmospheric stabilities, (d) estimate soil flux to both the groundwater and the atmosphere, (e) estimate the permeabilities of the basalt and sediments to air, (f) refine data quality objectives for further investigation and monitoring of the vadose zone, and (g) establish remediation goals. All data will ultimately provide input to the baseline risk assessment, which will be performed to estimate the risk to people and the environment from the contaminants that are found to be present.

1.13 Corrective Actions

Corrective action will be initiated when the project objectives are not met or when assessment of the data reveals questionable or unknown data quality. Corrective action may be initiated by any individual on the project, subject to approval by the project manager. These corrective actions will include, but are not limited to, modifications of the sampling procedure, sampling design, analytical techniques within EPA-approved guidelines, and data reporting procedures.

1.13.1 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements lies with the field personnel. The FTL is responsible for verifying that all QA procedures are followed. This requires that the FTL assess the correctness of field methods and their ability to meet QA objectives, and to make a subjective assessment of the impact a procedure change will have on field objectives and subsequent data quality. If a problem occurs that might jeopardize the integrity of the project, cause a QA objective not to be met, or impact data quality, the FTL will immediately notify his/her project supervisor.

The FTL will document the situation, the field objectives affected, the corrective action taken, and the results of that action. Copies of the documentation will be provided to the project manager and the project QA officer.

Corrective action will be implemented when the project objectives are not met or when the conditions adverse to quality have been identified. Conditions adverse to quality shall be promptly identified and corrected as soon as possible. The identification, cause, and corrective actions to prevent recurrence shall be determined and documented for significant conditions adverse to quality.

1.13.2 Laboratory Corrective Action

The laboratory corrective action plan will be detailed in the laboratory quality assurance program plan. The need for corrective action may come from several sources: equipment malfunctions, failure of internal QC checks, method blank contamination, failure of performance or system assessments, and noncompliance with QA requirements. ERD PD 5.5, "Obtaining Laboratory Services," ERD PD 5.6, "Nonconformance," and ERD QPP-149 (EG&G Idaho 1991a) outline ERD requirements for laboratory QA/QC and reporting requirements.

2. Field Sampling Plan

2. FIELD SAMPLING PLAN

2.1 Site Background

The RWMC, located near the southwestern corner of the INEL, was selected in 1952 by the AEC, predecessor to the DOE as a disposal site for solid low-level waste generated by INEL operations. This selection was based on the near surface geohydrological studies by the USGS and AEC criteria. The RWMC occupies 144 acres. Buried wasted is contained in the 88-acre SDA. In addition to waste generated at the INEL, waste from the DOE's Rocky Flats Plant near Golden, Colorado, and other DOE facilities, are stored and disposed of at the RWMC.

The current RWMC mission is to provide waste management for the present and future needs of the INEL and assigned DOE offsite generators of low-level waste and transuranic waste and to receive, examine, and certify stored transuranic waste for ultimate shipment to the DOE Waste Isolation Pilot Plant in Carlsbad, New Mexico.

Refer to Section 2.1 in the Focused RI/FS Work Plan (EG&G Idaho 1992a) for more details on the RWMC site background.

2.2 Existing Data

In 1987, chlorinated VOCs were discovered at the RWMC in the groundwater (USGS 1988). VOCs were found in:

- Drinking water (EG&G Idaho 1989)
- Samples of perched water (EG&G Idaho 1989)
- Soil-gas samples (EG&G Idaho 1989)
- Ambient air above the soil surface (EG&G Idaho 1988).

The VOCs found to date include:

- Carbon tetrachloride (CCl_4)
- Trichloroethylene (TCE)
- Chloroform ($CHCl_3$)
- 1,1,1-trichloroethane (TCA)
- 1,1,2-trichloro-1,2,2-trifluorethane (Freon-113)
- Tetrachloroethylene (PCE).

Refer to Section 3 of the Focused RI/FS Work Plan (EG&G Idaho 1992a) for further details of previous characterization of volatile organic contamination at the RWMC. In addition, Section 4 of the OCVZ Focused RI/FS Work Plan provides an evaluation of available data.

2.3 Sampling Objectives

The objectives of this Focused RI/FS are to (a) determine the nature and extent of the volatile organic contamination in the RWMC vadose zone, (b) evaluate the risk posed to the public to the environment by the release of volatile organics to the atmosphere and groundwater, and (c) select the best remediation alternative based on the CERCLA criteria of implementability.

The data obtained from sampling activities will be used to: (a) project the rate of release of organic vapors from the buried waste at the SDA, (b) determine the organic flux to the atmosphere and groundwater, (c) determine the transport parameters in the vadose zone and aquifer, (d) refine data quality objectives for further investigation and monitoring of the vadose zone, and (e) determine baseline levels of VOCs in the vadose zone, perched water zone, and groundwater zone below the RWMC to define baseline risk and remediation goals.

Justifications for the OCVZ Focused RI/FS tasks are included in the Focused RI/FS Work Plan, Section 5 (EG&G Idaho 1992a).

The collection of baseline samples at designated time intervals will also help identify natural variations in VOC concentration that may occur because of changes in barometric pressure, temperature, or other seasonal/temporal variables. The baseline sampling of the perched water zone will provide data on present VOC contamination concentrations in the perched water. These data will then be compared to contaminant concentrations in the water in the same wells during operation of the VVE system.

The analysis of gas samples will be performed for VOCs including carbon tetrachloride, tricloroethylene, and chloroform. The water samples will be analyzed for VOCs, semi volatiles, anions, radionuclides, and metals as specified in Table 1-2. The water samples will also be screened for alpha and beta/gamma-emitting radionuclides prior to offsite shipment. Samples indicating gross alpha/beta activity will be analyzed for specific radionuclides. Water and soil-gas sample results will be used to determine the in situ coefficient for the Henry's Law gas constant, which defines the equilibrium vapor-liquid phase concentration relationship.

2.4 Sample Location and Frequency

Described below are the 14 specific tasks planned in the Focused RI/FS (EG&G Idaho 1992a). Figure 2-1 is a map of all sampling locations, sampling types, and location designations in and around the SDA. Well depths for all existing wells are in Appendix M. Descriptions of the 14 tasks planned in the focussed RI/FS are given below:

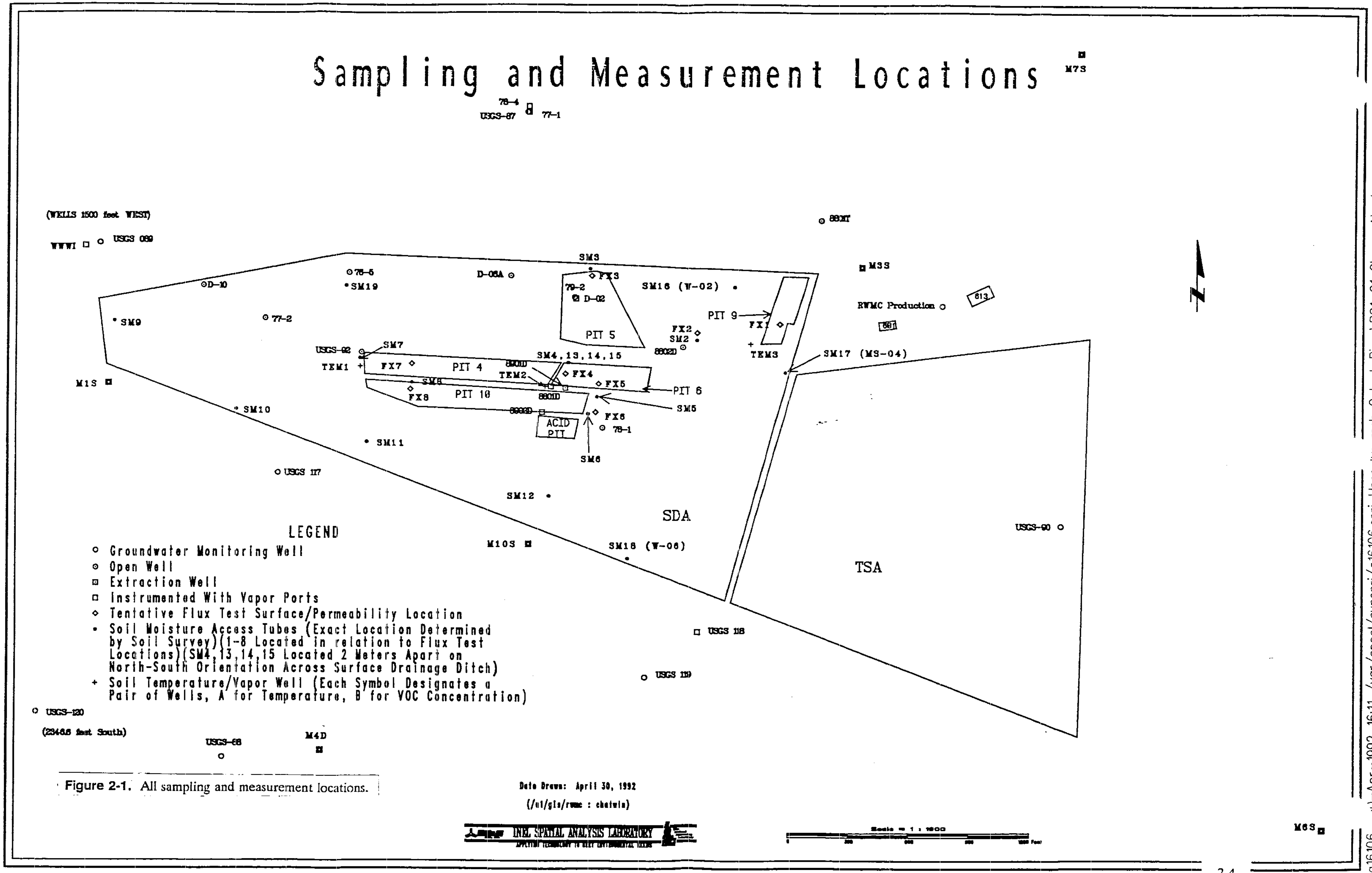

Figure 2-1. All sampling and measurement locations.

1. **Soil Temperature and Vapor Concentrations.** Three well pairs, designated TEM-1 A & B, TEM-2 A & B, and TEM-3 A & B, will be drilled near Pit 9 to the top of basalt and instrumented every 2 ft (Figure 2-4) with vapor ports (A series) and thermistors (B series). DASs will be used to record temperature every two hours. The vapor ports will be sampled once a month and analyzed for VOCs using the portable GC (located in WMF-726). See Figures 2-1 and 2-2 for locations of the TEM wells.

2. **Vapor Port Monitoring.** Vapors will be collected from six existing ported wells. Gas sampling ports will also be placed on the six ground water monitoring wells to be drilled in Fiscal Year 1992 within the Groundwater Operable Unit OU 7-02. These wells will be located outside the SDA, and at least 36 vapor monitoring ports will be installed at various depths. At least six gas sampling ports will be placed in USGS Well 118 at specific intervals and the well backfilled. Details concerning installation of vapor ports is provided in Appendix I.

   Those wells will be drilled to expand the existing groundwater and subsurface vapor monitoring well network. Well designations are as follows:

Existing	New
8801D (nine ports)	M7S
8902D (eight ports)	M3S
D02 (eight ports)	M1S
77-1 (six ports)	M10S
78-4 (five ports)	M16S
WWW-1 (seven ports)	M4D

   The vapor ports in the proposed wells will be placed to determine the spatial (depth) distribution of VOCs in the subsurface gas. Port depths for the new wells will be determined prior to installation of the ports, based on an even spacing between the aquifer and ground surface (special emphasis below the 240 ft depth), regions of elevated VOC levels from borehole drilling, and rubble/interbed zones. If existing information is not adequate to determine port depths, the new wells will be sampled with a packer system to determine optimum port depth. See Figure 2-1 for the locations of these 13 wells.

   Vapor from various depths at each of these 13 wells will be sampled at least twice per month for the duration of the RI, and analyzed on-site using the portable GC.

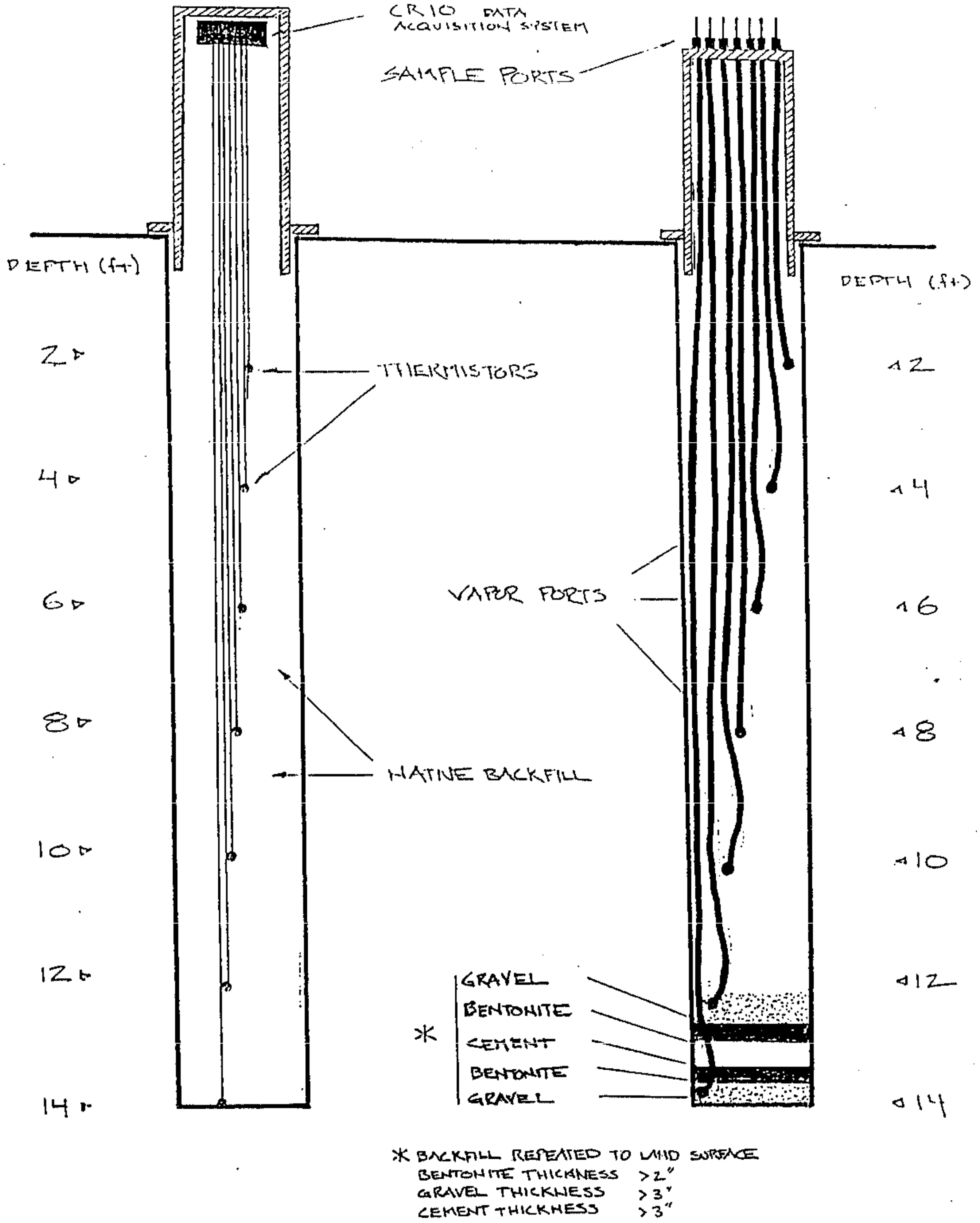

Figure 2-2. Vapor port and thermistor installation.

3. **Perched Water.** Perched water will be collected from wells USGS-92, 78-1, 8802D, 77-2, and D-10 quarterly. Water levels will be recorded prior to sampling, and physical parameters will be measured at the sample site. See Figure 2-1 for the locations of perched water wells. Refer to EDF ERP-VVED-065, Appendix M, for details concerning well completion, and total depth of completed wells.

4. **Vapor Port Permeability.** A pressure transducer is lowered into the sample port. A vacuum pump and flowmeter are then connected to the port. The pump is started and pressure changes are recorded on a DAS to estimate the permeability of the material adjacent to the vapor port. This test will be performed one time only at all ports on all six existing vapor port monitoring wells, the vapor ports on the six new groundwater/vapor port monitoring wells and USGS 118. The wells are 8801D (nine ports), 8902D (eight ports), 77-1 (six ports), DO2 (eight ports), 78-4 (five ports), and WWW-1 (seven ports) (see Figure 2-1). vapor port permeability will be measured in all new vapor ports. In addition to permeability at each port, the sample volume required to obtain a representative vapor sample from each port will be determined by measuring vapor concentrations over time during purging.

5. **Basalt Tracer Studies.** Both horizontal and vertical diffusion will be measured in the subsurface. For determination of the vertical, horizontal diffusion, tracer gas will be injected into a vapor port in Well 77-1 at approximately a 112 ft depth through a calibrated gas flow meter. Ports in Wells 78-4 (located at 78 ft and 119 ft) and 77-1 (located at 66, 104, and 151 ft) will be sampled at regular intervals and analyzed on the portable GC (located in WMF-726) to detect breakthrough to the ports. The design of the test is such that the injection and removal pressures are very small so advective effects will not be introduced. Wells 77-1 and 78-4 are approximately 30 feet apart; these wells have been cored and logged, and the stratigraphy is understood and documented (EG&G Idaho 1989a). The zones being monitored for horizontal diffusion analysis are stratigraphically similar. The stratigraphy involved in the vertical diffusion analysis is understood. Basalt tracer studies will be conducted one time only. See Figure 2-1 for the locations of these wells.

6. **Downhole Barometric Pressure/VOC Concentration.** The effect of barometric pressure on vapor concentrations in Well 8801D (Figure 2-1) will be measured. A DAS will record downhole barometric pressure at the 50-ft port depth while an automatic sampler collects vapor samples at 12-hour intervals at the same depth for subsequent portable GC analysis.

7. **Meteorological Data.** Local temperature, barometric pressure, wind speed and direction, and precipitation will be monitored for the duration of all testing at multiple locations at or near the RWMC SDA.

8. **Stratigraphy and Structural Geology.** A comprehensive literature survey study will be performed to compile relevant data necessary for developing a description of geologic stratigraphy and describe the geological features most influential in VOC migration in the vadose zone. These geological properties will be determined from geophysical logging operations as well as evaluation of subsurface cores.

   The Groundwater Operable Unit OU 7-06 plans to drill six new groundwater monitoring wells. Coring of the 110-ft and 240-ft interbeds for the six wells will be performed. These cores will be tested for physical properties (density, porosity, gas permeability, etc.) and analyzed for chemical content (VOCs, semi-volatiles, inorganics, metals, and radioactivity). The cores will be used to determine if the extrapolation of information from shallow depths is appropriate. The geological characteristics need correlation and interpretation to stratigraphic control points.

   Five types of geophysical logs will be performed on the six groundwater monitoring wells being installed under the Groundwater Operable Unit: gamma-ray, gamma-gamma, neutron, resistivity, and caliper logs. Borehole geophysical surveys along with detailed geological logging will spatially identify water-bearing zones in the vadose zone, vadose zone porosities, and possible fracture geometries; outline site-specific geological controls on water movement, and define the site-specific stratigraphy. Geophysical surveys and geological logs from the deep well or wells will provide stratigraphic information and geological controls on water movement deep within the aquifer.

9. **Open Well Vapor Sampling.** The open (uncased) well vapor sampling activity consists of two separate tasks: (a) well gas sampling and (b) shallow well screening. The two tasks are described below.

   a. **Well Gas Sampling.** Subsurface soil vapor will be collected once a month for the duration of the investigation from the 9 (USGS 92, 8802D, 77-2, 78-1, D-10, 8801T, 79-2, DO-6a and 76-5) existing open wells shown in Figure 2-1. In addition the extraction well (8901D) and USGS 118 will be sampled. Open well vapor sampling of USGS 118 will be used to locate vapor ports. The wells have been drilled to various depths and the inflatable packer system will be used to pack each well off at a selected sampling depth. Figure 2-3 represents the chosen interval graphically. The shaded area represents elevated vapor plume VOC levels based on existing knowledge of the vapor plume. Figure 2-4 represents the known location of the interbeds. Sampling frequency and locations will be based on initial results.

b. **Shallow Well Sampling.** Twenty five (25) wells and boreholes at the RWMC that are less than 20 ft deep will be screened using a portable GC. The vapor sample will be collected by lowering a Teflon tube to the bottom of the well and pulling a sample into tedlar bag for subsesequent analysis. These wells include those around and in the Acid Pit (AP-01 thru AP-12), around Pit 9 (P9-01 thru P9-08), MS-04, NAT-02, MS-05, W-03, and MS-03.

Table 2-1. Subsurface vapor and water sample depths (ft).

8801-D*	WWW-1*	8902-D*	A. 77-1*	A. 78-4*	A. VZT-1	B. 79-2	B. DO2*
30.6 - 35.4	9.2 - 21.4	25.5 - 32.0	59 - 69	70.5 - 81.0	48 - 78	20 - 50	25.0 - 30.0
48.0 - 53.0	39.0 - 63.5	43.5 - 48.6	97 - 104	114.5 - 122.0	78 - 108	50 - 80	57.0 - 62.0
74.0 - 79.0	67.7 - 80.5	68.0 - 73.0	108 - 114	223.0 - 230.0	108 - 134	80 - 110	66.0 - 71.0
90.0 - 95.0	127.1 - 151.0	79.5 - 105.0	146 - 164	250.0 - 256.0		110 - 140	97.0 - 101.0
100.0 - 105.0	170.0 - 188.0	124.0 - 132.0	181 - 224	330.5 - 340.0		140 - 170	123.5 - 129.0
128.6 - 133.6	230.0 - 250.0	175.0 - 180.0	364 - 380			170 - 217	163.0 - 168.0
165.0 - 170.0		194.5 - 199.7					190.0 - 195.0
190.0 - 195.0		221.4 - 238.0					227.2 - 233.0
227.7 - 232.7							

RWMC PROD**	USGS-89**	USGS-117**	USGS-87**	USGS-88**	USGS-90**	USGS-119**	USGS-120**
560 - 600	576 - 600	555 - 600	H_2O @ 580'	H_2O @ 589'	H_2O @ 582'	H_2O @ 604'	H_2O @ 615'
601 - 635	610 - 646	610 - 653					
+H_2O	+H_2O	+H_2O					

USGS-92***	78-1***	8802D***	77-2***	D-10***	USGS-118[1]	D-6A	8901D	76-5	8801T
15 - 45	83' + H_2O	221 + H_2O	36' + H_2O	200'+ H_2O	220 - 250	10 - 30	90 - 130	10 - 40	15 - 35
45 - 75					250 - 300	30 - 50	130 - 160	40 - 70	35 - 50
75 - 105					300 - 350		130 - 160	70 - 100	
105 - 135					350 - 400		160 - 190		
135 - 165					400 - 450		190 - 220		
165 - 195					450 - 500		220 - 240		
195 - 210					500 - 550				
+ H_2O									

A B These wells will be used to compare sample results based on their proximity

* Vapor vacuum extraction program wells

** (Groundwater) These wells can have vapor samples taken if the water table declines to expose the open portion of the well to the vadose zone

*** Perched water and vapor samples

1 Open borehole outside southern border of RWMC to be used for establishing correct packer procedure, as required

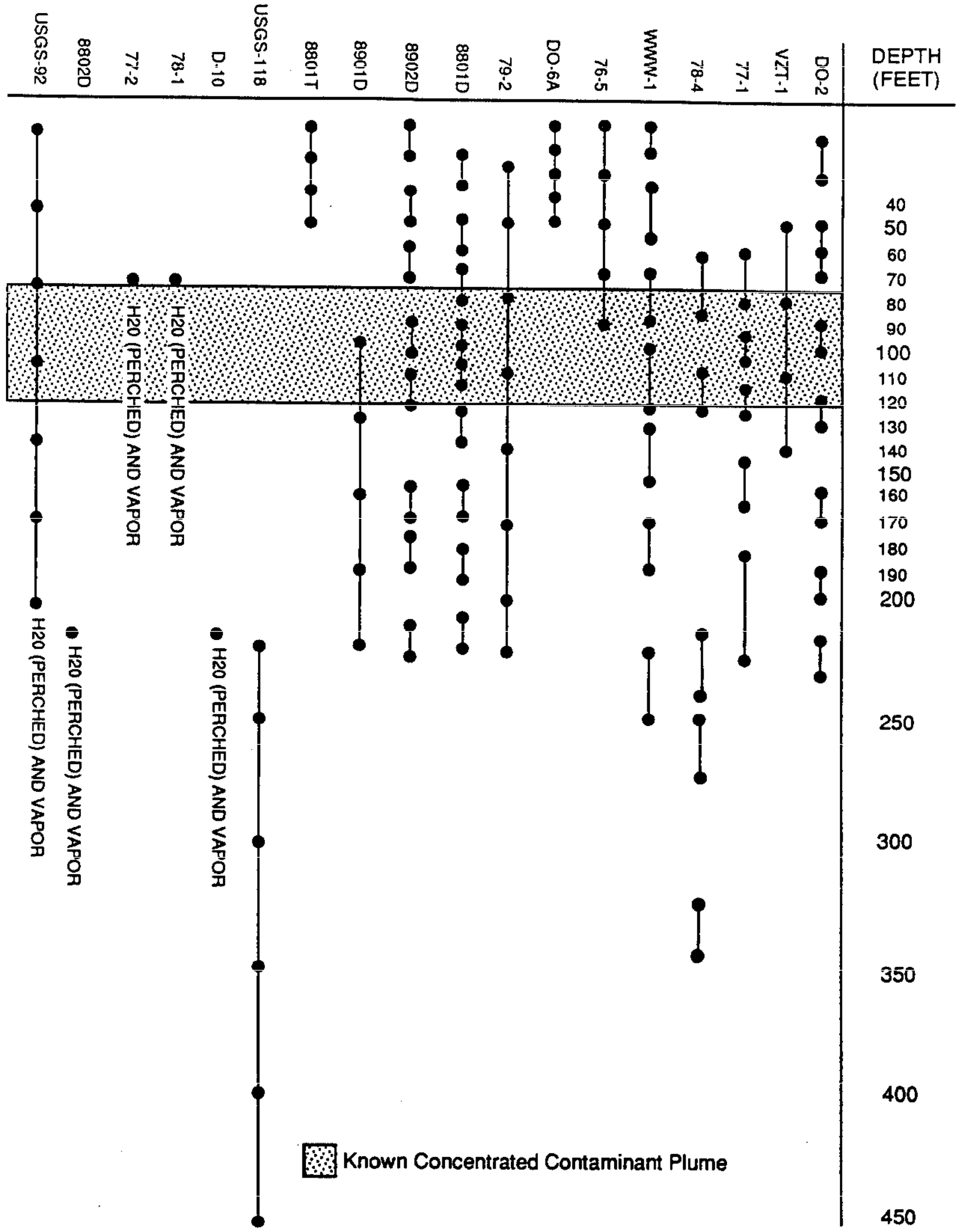

Figure 2-3. Selected subsurface vapor sample intervals.

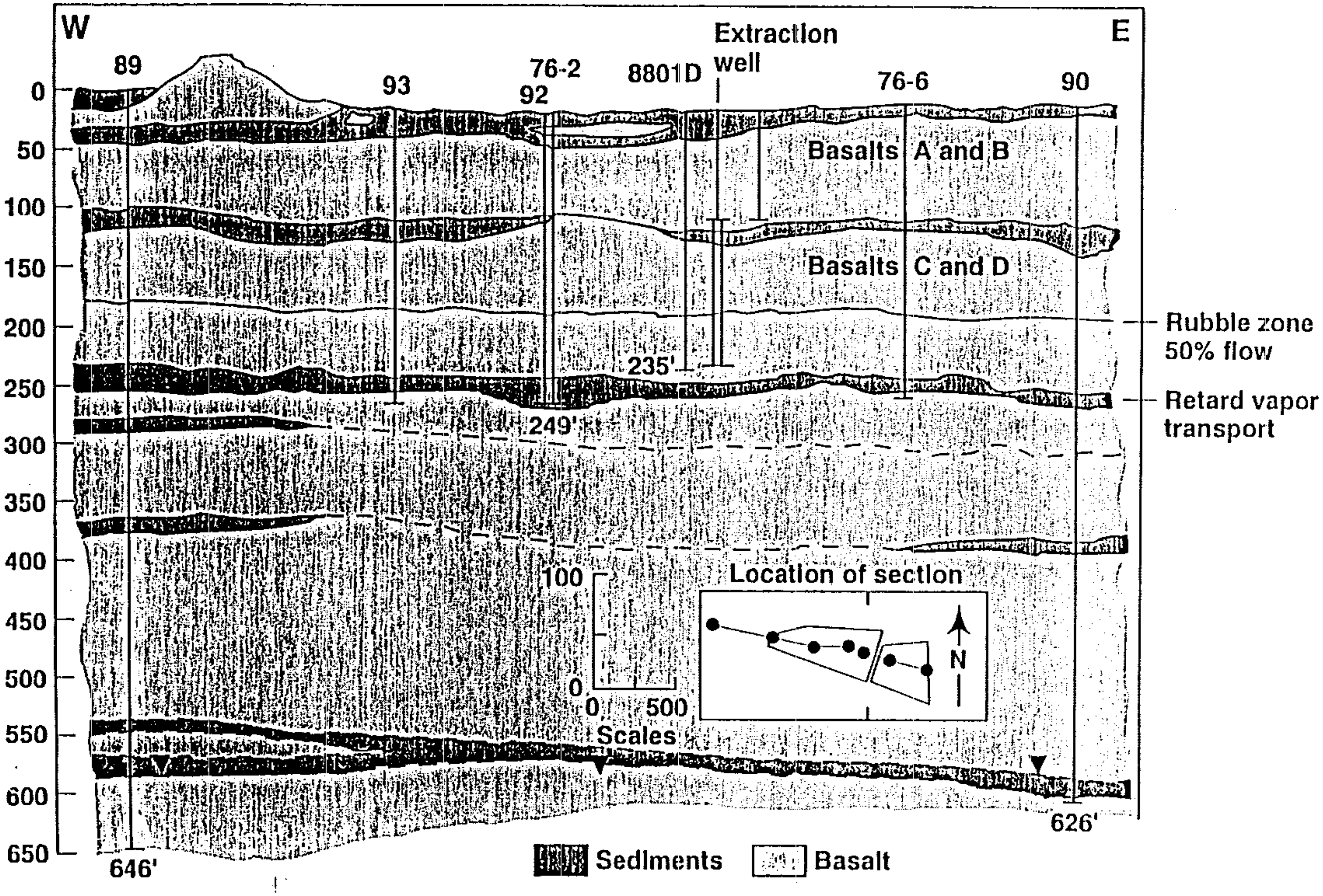

Figure 2-4. Surficial sediments and interbeds at the RWMC.

10. **Groundwater Quality and Elevation.** A groundwater characterization plan was developed to evaluate the groundwater conditions for the SDA (Wood and Wylie 1991). This plan proposed upgrading the present monitoring network with the installation of 35 additional monitoring wells and core holes. Evaluation of the groundwater exposure pathway is the responsibility of the Groundwater Operable Unit OU 7-06. The OCVZ, OU 7-08 Baseline Risk Assessment (BRA), however, requires data on the groundwater pathway. The VOC flux to the groundwater and the potential for ingestion and inhalation of VOCs via this exposure route may be an important contributor to the potential for adverse health effects. Data from the Groundwater/ Snake River Plain Aquifer investigation begun in Fiscal Year 1992 will be used to meet data requirements for the Operable Unit 7-08 BRA and Focused RI/FS.

11. **Treatability Studies.** Refer to Section 5.7 of the work plan (EGG-WM-10049) for this task.

12. **Soil-Gas Survey (Contingent).** Near surface soil vapor samples will be collected from the locations within the SDA (Figure 2-5) using a vapor probe sampler. A full-size map with all soil-gas sampling locations and designations will be utilized by the field team during actual sampling activities 91 locations in the SDA located on an approximate 200 ft systematic grid. The vapor probes will be inserted into the ground surface to a maximum depth of 2.5 ft. Field screening with a portable volatile organic vapor analyzer will be used to optimize subsequent portable GC analysis of the soil gas and to determine whether the vapor probe will be left in the ground for subsequent sampling. If total VOC concentrations of >100 ppm are detected, the probe will be labeled and left in place. If <100 ppm, the location will be logged in the sampling logbook. All soil-gas samples will be analyzed with a portable GC for VOCs calibrated for carbon tetrachloride, chloroform, and trichloroethylene.

13. **VOC Surface Flux (Contingent).** The flux chamber is designed to measure emission (flux) of VOCs from the ground surface. The flux chamber is an enclosure device that provides a defined surface area from which to sample. Clean, dry sweep air is added to the chamber at a fixed rate. The volumetric flow rate of sweep air through the chamber is recorded and the concentration of the VOCs is measured at the exit of the chamber. Flux measurements will be performed at eight locations across the SDA (see Figures 2-1 and 2-3) designed to encompass areas exhibiting a

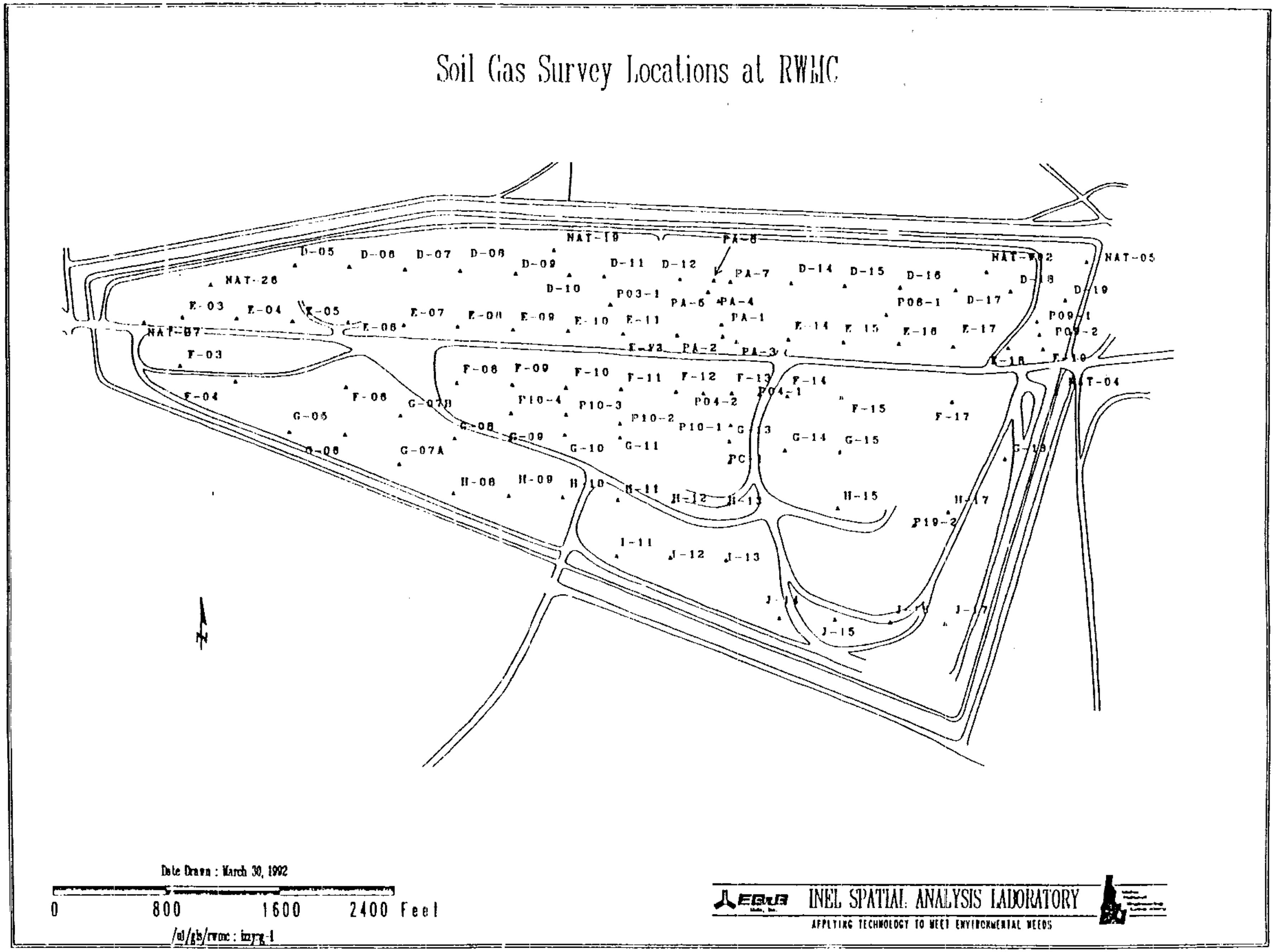

Figure 2-5. Soil gas sample locations at the RWMC SDA.

representative range of fluxes for the SDA and based on the results of a soil-gas survey. Based on the eight locations, the mean emission rate (ug/min·m^2) for the SDA can be determined for use in the air transport model. A permeameter will be set up to measure surface soil permeability during surface flux tests. Locations and sampling frequency of surface soil permeability will be the same as for the flux testing. In addition, soil moisture will be measured in conjunction with these flux tests (see task 2).

14. **Soil Moisture Measurements (Contingent).** A total of 18 shallow boreholes (SM-1 through SM-18) will be used to measure soil moisture. Fifteen boreholes, to depths of not greater than 30 ft, will be drilled in the SDA at designated locations, with 8 of the 18 near the flux test locations. A steel pipe will be placed in the hole and measurement of soil moisture content at 1-ft intervals will be made using a neutron probe. Soil moisture measurements will be made monthly in winter, spring, and summer seasons. The measurements located near the flux test locations (SM-1 through SM-8) will be made on the same day as the flux texts. See Figures 2-1 for locations of soil moisture bore holes. Note that SM-8, SM-14, SM-15, and SM-16 will be located on a north-south line, approximately 2 m apart, crossing a surface drainage ditch. This ditch is believed to be a major water infiltration source during rain events, and thus, is an area of interest.

2.4.1 Sample Identification

The existing sample numbering scheme for Scentograph GC analyses will be used for gas samples that are not to be shipped to an off site laboratory. The designation will be as follows:

Well number - depth or port number (for monitoring wells so equipped) - (A) analysis, (D) duplicate, or (R) Co-located - dilution factor

Examples:

DO2-1-A-1 = Well DO2, port 1, analysis (meaning first sample drawn from bag), no dilution

8801D5-D-5 = Well 8801D, port 5, duplicate (meaning second sample drawn from a bag), 5x dilution

771-5-R-10 = Well 77-1, port 5, co-located (meaning second bag of sample from same location), 10x dilution.

Quality control sample designators will be as follows:

CCl_4 = This is an internal instrument calibration using a certified calibration gas.

STD-52.2-10 = This is a field standard using the 52.2 ppm carbon tetrachloride calibration gas in a Tedlar bag, 10x dilution.

BLANK = This is a sample of the room air to ensure that there is no residual gas in the detector. When the previous sample is a high concentration (>200 ppm), the operator will run several blanks to clean out the column and detector.

A systematic character code will be used to number perched water and vapor samples to be shipped to an off site laboratory. The sample identification root code will begin with the letters VZC. The remainder of the sample identification code will be in accordance with ERD QPP-149 (EG&G Idaho 1991a). Replicate samples shipped to off-site analytical laboratories will be submitted as blinds. Table 2-2 summarizes the type of sample, location, and analyses for off site samples.

Table 2-2. Summary of sample type, location, and analyses for off site samples.

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Project Manager: G. MATTHERN/R. LUGAR
Form No: SAP11B

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										AN	C1	GR	OS	R6	VV														
VZC001	REG	GROUND WATER	GRAB		/ /	RWMC TASK 3	USGS 92	PW WELL		1	1	1	1	1	1														
VZC002	REG	GROUND WATER	GRAB		/ /	RWMC TASK 3	78-1	PW WELL		1	1	1		1	1														
VZC003	REG	GROUND WATER	GRAB		/ /	RWMC TASK 3	8802D	PW WELL		1	1	1		1	1														
VZC004	REG	GROUND WATER	GRAB		/ /	RWMC TASK 3	77-2	PW WELL		1	1	1		1	1														
VZC005	REG	GROUND WATER	GRAB		/ /	RWMC TASK 3	D-10	PW WELL		1	1	1		1	1														
VZC006	QC	WATER	TBLK		/ /	RWMC TASK 3	QC	TRIP BLANK							1														

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: Anions
AT2: CLP Metals
AT3: Gamma Screen/Analysis
AT4: CLP Semivolatiles
AT5: Gross Alpha/Beta
AT6: VOAs CLP 3/90
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

Planned dates are June 8 - September 30, 1992.

Table 2-2. (continued).

SAP Number: EGG-WM-10175-1
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Project Manager: G. MATTHERN/R. LUGAR

Form No: SAP118

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
										AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	VT																			
VZC007	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	WWW-1	PORT 1	240	1																			
VZC008	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	WWW-1	PORT 3	135	1																			
VZC009	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	8801	PORT 4	77.5	1																			
VZC010	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	M3S	PORT 1		1																			
VZC011	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	M3S	PORT 2	505-508	1																			
VZC012	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	M3S	PORT 3	330-335	1																			
VZC013	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	VVE-10	PORT 1	186-191	1																			
VZC014	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	VVE-10	PORT 2	133-138	1																			
VZC015	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	VVE-10	PORT 3	70-75	1																			
VZC016	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	8902	PORT 6	70.5	1																			
VZC017	SPLIT	SOIL GAS	GRAB		/ /	RWMC1 TASK 2	D02	PORT 2	59.5	1																			
VZC018	QC	SOIL GAS	FSTD		/ /	RWMC1 40-60 PPM	00	PORT 00FS		1																			
VZC019	QC	SOIL GAS	TBLK		/ /	RWMC1 0 PPM	00B	PORT 00B		1																			

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: VOCs (Mod. TO-14 or Mod. 8240/8260)
AT2:
AT3:
AT4:
AT5:
AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

Planned dates are June 8 - September 30, 1992.

Table 2-2. (continued).

SAP Number: EGG-WM-10175-2
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SAMPLE DESCRIPTION					PLANNED DATE	SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD		AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										VT																			
VZC020	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 1	TEM3	PORT 1	DEEPEST	1																			
VZC021	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 1	TEM3	PORT TBD	SHALLOWST	1																			
VZC022	QC	SOIL GAS	REPL		/ /	RWMC2 TASK 1	TEM3	PORT 1	DEEPEST	1																			
VZC023	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 2	M1S	PORT 1-DEEPEST	240	1																			
VZC024	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 2	M10S	PORT 1-DEEPEST	240	1																			
VZC025	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 2	M3S	PORT TBD	+110	1																			
VZC026	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 2	M1S	PORT TBD	+110	1																			
VZC027	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 2	USGS 118 PACK	PORT 1-DEEPEST	550	1																			
VZC028	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 9A	USGS 92 PACK	PORT 1-DEEPEST	214	1																			
VZC029	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 9A	D-10 PACK	PORT 1-DEEPEST	224	1																			
VZC030	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 9A	DO-6A PACK	PORT 1-DEEPEST	50	1																			
VZC031	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 9A	76-5 PACK	PORT 1-DEEPEST	245	1																			
VZC032	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 9A	8802D PACK	PORT 1-DEEPEST	220	1																			
VZC033	SPLIT	SOIL GAS	GRAB		/ /	RWMC2 TASK 9A	USGS 92 PACK	PORT TBD	+110	1																			
VZC034	QC	SOIL GAS	FSTD		/ /	RWMC2 1-5 PPM	00	PORT OOFS		1																			

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: VOCs (Mod. TO-14 or Mod. 8240/8260)
AT2:
AT3:
AT4:
AT5:
AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

Planned dates are June 8 - September 30, 1992.

Table 2-2. (continued).

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SAMPLE DESCRIPTION					PLANNED DATE	SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD		AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										VT																			
VZC035	QC	SOIL GAS	FSTD		/ /	RWMC2 >500 PPM	00	PORT 00FS		1																			
VZC036	QC	SOIL GAS	TBLK		/ /	RWMC2 0 PPM	00B	PORT 00B		1																			

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: VOCs (Mod. TO-14 or Mod. 8240/8260)
AT2:
AT3:
AT4:
AT5:
AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

Planned dates are June 8 - September 30, 1992.

Table 2-2. (continued).

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SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

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Form No: SAP118

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										VT																			
VZC037	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	M4D	PORT TBD	+110	1																			
VZC038	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	M6S	PORT TBD	+110	1																			
VZC039	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	M7S	PORT TBD	+110	1																			
VZC040	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	M4D	PORT 1-DEEPEST		1																			
VZC041	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	M6S	PORT 1-DEEPEST		1																			
VZC042	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	M7S	PORT 1-DEEPEST		1																			
VZC043	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	USGS 118	NEAR 110' INTBD		1																			
VZC044	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 2	USGS 118	PORT 1-DEEPEST		1																			
VZC045	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 9A	8901D	NEAR 110' INTBD		1																			
VZC046	QC	SOIL GAS	FSTD		/ /	RWMC3 40-60 PPM	00	PORT 00FS		1																			
VZC047	QC	SOIL GAS	FSTD		/ /	RWMC3 1-5 PPM	00	PORT 00FS		1																			
VZC048	QC	SOIL GAS	TBLK		/ /	RWMC3 0 PPM	00B	PORT 00B		1																			
VZC049	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX1-CONTINGENT	PIT 9 FLUX		1																			
VZC050	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX2-CONTINGENT	NO PIT FLUX		1																			
VZC051	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX3-CONTINGENT	PIT 5 FLUX		1																			

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: VOCs (Mod. TO-14 or Mod. 8240/8260)
AT2:
AT3:
AT4:
AT5:
AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

Planned dates are June 8 - September 30, 1992.

Table 2-2. (continued).

SAP Number: EGG-WM-10175-3
SAP Table No. 1
Date: 07/13/92 Revision: 4.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: OU 7-08, VADOSE ZONE ORGANICS RI/FS

Page 2 of 2

Project Manager: G. MATTHERN/R. LUGAR

Form No: SAP11B

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										VT																			
VZC052	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX4-CONTINGENT	PIT 6 FLUX		1																			
VZC053	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX5-CONTINGENT	PIT 11 FLUX		1																			
VZC054	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX6-CONTINGENT	PIT 12 FLUX		1																			
VZC055	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX7-CONTINGENT	PIT 4 FLUX		1																			
VZC056	SPLIT	SOIL GAS	GRAB		/ /	RWMC3 TASK 13	FX8-CONTINGENT	PIT 10 FLUX		1																			
VZC057	QC	SOIL GAS	FSTD		/ /	RWMC3 1-5 PPM	00	PORT 00FS		1																			
VZC058	QC	SOIL GAS	TBLK		/ /	RWMC3 0 PPM	00B	PORT 00B		1																			

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: VOCs (Mod. TO-14 or Mod. 8240/8260)
AT2:
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AT6:
AT7:
AT8:
AT9:
AT10:

AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

COMMENTS

Planned dates are June 8 - September 30, 1992.

2.4.2 Personnel Safety and Health Precautions

The latest revision of task-specific health and safety plan for the OCVZ Focused RI/FS (EG&G Idaho 1992b) will be adhered to. All field staff members are responsible for understanding and complying with all requirements of this sampling and analysis plan and the health and safety plan. All field staff will be trained to comply with the health and safety plan and will sign the certification form before performing any field work. A site work release will be required prior to initiating work on specific tasks described in the SAP, and the health and safety plan will provide the specific personnel protection requirements. All field staff will be briefed during a morning meeting before the start of each day's activities to make them aware of site-specific conditions and to discuss any safety or health related questions they may have pertaining to the assigned tasks.

2.5 Sampling Equipment and Procedures

The following procedures contain only procedures for performing each task. Health and safety requirements are dictated in the health and safety plan (EG&G Idaho 1992b). Containerization, preservation, documentation, sample handling, data flow, and shipping procedures are covered in other portions of this SAP.

All sampling tasks that involve auguring soil or collection of vapors from other than the vapor ports will be monitored using a total organic vapor detector while being performed. The procedures for use of the portable total organic vapor detector are located in Appendix B, ETSOP-40.

2.5.1 General Sampling Equipment

General sampling equipment includes

- Sample tags and labels
- Gloves (Per Health and Safety Plan)
- Chain-of-custody forms and seals
- Coolers

- Blue Ice[a] for shipping (Water samples only)
- Xitech vacuum box[a]
- Tedlar bags[a]
- Parafilm
- Teriwipes[a]
- Level D protection
- Tape—cellophane, fiberglass reinforced, and duct
- Permanent black markers and pens
- Stopwatch
- 100-ft measuring tape
- Gloves (Per Health and Safety Plan)
- 1-gal zipper plastic bags
- Garbage bags
- Polyethylene plastic sheeting
- Scissors, Xact-o knife[a]
- Marker flags
- Aluminum foil
- pH paper
- Laboratory "Request for Analysis" forms

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[a] Mention of specific products and/or manufacturers in this document implies neither endorsement or preference, nor disapproval by the U.S. Government, any of its agencies, or EG&G Idaho, of the use of a specific product for any purpose.

- Cooler labeling ("Environmental Samples," "This Side Up," etc.)
- Logbooks
    - FTL logbook
    - Sample logbook
    - Instrument calibration logbook
    - Sampling shipping logbook
    - Decontamination logbook.

2.5.2 Sampling Procedures

See Table 2-2 for specific samples requiring off-site analyses.

2.5.2.1 Soil Temperature and Vapor Concentration. The vapor ports will be installed using the procedure found in RWMC Operations DOP 3.3.1, modified for smaller, shallower ports. Figure 2-4 depicts the construction of the ports. Procedures for sample collection are as follows:

Data acquisition system (DAS)	Appendix K
Vapor port sample collection	Appendix I
GC operational procedures	Appendix A
GC calibration	Appendix A and Section 1.6.1 of this SAP

2.5.2.2 Vapor Port Monitoring. Procedures for all steps in vapor port monitoring including vapor port sampling, GC operation, and GC calibration, are documented in the following:

Vapor port sample collection	Appendix I
GC operational procedures	Appendix A
GC calibration	Appendix A and Section 1.6.1 of this SAP

2.5.2.3 Perched Water. Procedures for all steps in perched water sampling, including collection, Hydrolab operation, water level measurement, and sample handling, are documented in the following:

Perched water collection	Appendix C
Sample handling	Appendix D and Section 2.6 of this SAP
Hydrolab operation	Appendix C
Measurement of groundwater levels	Appendix C

Obtaining a sample via bailing provides the more representative sample as opposed to pumping. Further it is the method of choice when low well bore volumes are encountered.

2.5.2.4 Vapor Port Permeability. Permeability of the basalt varies by depth and relative position under the SDA. This procedure provides guidance to properly conduct gas port permeability tests of basalt in vapor-ported wells. Since permeability is an important parameter in modeling and simulating VOC transport, improved estimates of permeability at each port location is essential information. The permeability tests require pumping vapors from each port, while simultaneously monitoring the flow rate and port pressure over time. This SOP is to ensure quality control and to provide instructions to personnel performing characterization work.

The following materials are be needed for this procedure:

- Vacuum pump with fittings
- Downhole pressure transducer
- Flow meter
- DAS (Appendix K)
- Regulated power supply (Appendix J).

The steps of the procedure include:

1. The pressure transducer will calibrated using NIST traceable standards. An ERD calibration and standardization logbook will be used to record calibration methods and results. The flowmeter will be calibrated by the EG&G Idaho Calibration Laboratory and checked before use.

2. Lower the pressure transducer to the desired vapor port depth.

3. Log the well identification, port number, and depth in the field sample logbook (to within 5 ft).

4. Connect the pressure transducer to the regulated power supply and the DAS.

5. Verify that the system is operating. Setup and use of the DAS will be in accordance with the manufacturer's operating and maintenance manual (Campbell Scientific 1991).

6. Connect the vacuum pump and flow meter to the port.

7. Connect the flow meter to the DAS.

8. Start the DAS at a five-second polling interval and observe the flowmeter and pressure transducer readings.

9. Record the initial values in the sample logbook.

10. Close the valve to the vacuum pump, start the pump, open the valve, and observe the pressure readings to steady state (no regular change for 60 seconds).

11. Record the approximate time to steady state and values reached at steady state.

12. Remove the test equipment and move it to the next port or well.

2.5.2.5 Basalt Tracer Studies. Injection of the tracer will be as stated in the subcontract SOW for tracer services. Sample collection will be as follows:

Vapor port sample collection	Appendix I
GC operational procedures	Appendix A
GC calibration	Appendix A and Section 1.6.1 of this SAP

2.5.2.6 Downhole Pressure/VOC Concentration. The purpose of this procedure is to generate a data set consisting of three data sequences: (1) barometric pressure, (2) VOC concentrations, and (3) the rate of barometric pressure change. This procedure is to ensure quality control and to provide instructions to samplers performing work for the ERD.

A pressure transducer is lowered to a specific port depth to measure barometric pressure while that port is being sampled. An automatic sampler is connected to the sample port to pull samples for concurrent analysis.

Calibration of the barometric and downhole sensors will be carried out using existing procedures in the operating and maintenance manuals.

The following materials and equipment will be needed:

- GC (Appendix A)
- Pressure transducer
- DAS (Appendix K)
- Automatic gas sampler capable of obtaining and retaining up to 14 samples
- Timer pump.

The pressure transducer will be lowered to the desired depth and connected to the DAS on the other end. The automatic sampler will be connected to the port opening containing the pressure transducer.

Setup of the DAS will be in accordance with the manufacturer's operating and maintenance manual (Campbell Scientific 1991). The DAS will record downhole barometric pressure at the 50-ft port depth of Well 8801D, while an automatic sampler collects vapor samples at 12-hour intervals. Samples from the automatic sampler and data from the DAS should be downloaded at least once per week. The samples will be collected for approximately a 28-day period or for two barometric cycles.

Data reduction will consist of plots of barometric pressure and VOC concentration versus time, rate of barometric change and VOC concentrations versus time, VOC concentration versus barometric pressure, and VOC concentration versus rate of barometric change.

Data reporting units and Quality Assurance (QA) objectives will be defined as follows

Units:	Pressure: ±0.1 KPa Concentration: mL/m^3 Time: Seconds
Precision:	Pressure: ±0.1 KPa Concentration: ± 10%
Accuracy:	Pressure: ±0.1 KPa Concentration: ± 20%.

2.5.2.7 Meteorological Data. Meteorological data are currently collected by a variety of agencies/organizations at the INEL. The USGS also maintains a weather station located within the SDA. This station will provide the most preferred and localized weather data for the SDA.

The USGS station is presently used for microclimate and evapotranspiration studies and includes a Met One wind direction/wind speed measurement system and data logging capability. The anemometer and vane sensors are located 2.5 m above the ground surface. In addition, this station records temperature and vapor pressure.

NOAA presently has a network of 33 weather stations in southeastern Idaho, with approximately one-third of these stations located on the INEL. There is a NOAA weather station located in the vicinity of the RWMC with a 10-m tower and data logging/transceiver capabilities.

EG&G Idaho operates two Climatronics weather stations located at the RWMC. One station is located at Building WMF-613 and has a tower approximately 10 m high. The other station and slightly smaller tower is located at the Health Physics Building, WMF-601. Both RWMC weather stations measure wind speed, wind direction, and temperature, and are equipped to measure precipitation. The WMF-613 station is presently equipped to continuously record these measurements on a chart recorder.

During the Remedial Investigation at the SDA, meteorological data from the USGS SDA station will be used as the primary meteorological data source.

2.5.2.8. Stratigraphy and Structural Geology. The stratigraphy and structural geology of the vadose zone beneath the SDA has been evaluated in past studies. A comprehensive literature survey will be performed to compile the relevant data which will develop a description of the geological features most influential in VOC migration in the vadose zone.

2.5.2.9. Open Well Vapor Sampling. The open well vapor sampling activity is comprised of two separate tasks: (a) well gas sampling, and (b) shallow well screening.

(a) Well Gas Sampling. The procedures to be used are contained in EGG-WM-9837, *Test Plan for Packer Procedures for the Collection of Soil Gas in Wells* (EG&G Idaho 1991b) (Appendix H). The wells will be sampled when testing is complete and an ERD-approved standard operating procedure is in place. A general description of the proposed procedure follows.

The volume of the packed zone and sample port will be purged 1.5 volumes prior to the collection of the sample. Samples will be collected in a 1-L Tedlar sample bag using a Xitech vacuum sample collection box in accordance with *RWMC Operations and Maintenance Management Manual*, Section 9.1.9.2 (Appendix I). All the samples for each well will be collected in sequence starting from the deepest sample depth and ending with the uppermost sample depth. Samples will be collected in the same well and depth sequence each quarter they are sampled.

The Tedlar sample bags will be labeled and transported to the portable GC laboratory for analysis.

Procedures for shallow well screening including portable organic vapor monitor sampling, GC operation, and GC calibration are documented in the following:

Vapor port sample collection	Appendix I
GC operational procedures	Appendix A
GC calibration	Appendix A and Section 1.6.1 of this SAP.

(b) Shallow Well Sampling. Wells and boreholes at the RWMC that are less than 20 ft deep will be analyzed using a portable GC. The vapor sample will be collected by lowering a Teflon tube to the bottom of the well and pulling a sample into a tedlar bag.

Procedures for shallow well sampling including portable GC operation, and GC calibration are documented in the following:

Vapor port sample collection	Appendix I
GC operational procedures	Appendix A
GC calibration	Appendix A and Section 1.6.1 of this SAP.

2.5.2.10. Groundwater Quality and Elevation. Past data collected by the USGS on groundwater quality and elevations have been valuable in developing a conceptual model of the Snake River Plain Aquifer response to recharge from the spreading areas. The evaluation of the groundwater exposure pathway is the responsibility of the Groundwater Operable Unit (OU 7-02). However, the OU 7-08 Baseline Risk Assessment (BRA) requires data on the groundwater pathway because VOC flux to the groundwater and the potential for ingestion of VOCs via this exposure route may be an important contributor to the potential for adverse health effects. Data from the groundwater (Snake River Plain Aquifer), beginning in Fiscal Year 1992, will be used as requirements for the OU 7-08 BRA and Focused RI/FS. Details concerning this task will be provided in the SAP for the Groundwater Operable Unit.

2.5.2.11. Treatability Study. Refer to Section 5.7 of the work plan (EGG-WM-10049) for this task.

2.5.2.12. Soil-gas Survey (Contingent). Soil vapor sampling involves withdrawing soil vapors from the subsurface for analysis to obtain information regarding the presence of volatile contaminants or their relative concentration differences in the subsurface soil vapor. The goal is to provide samples representative of the soil atmosphere with a high degree of reproducibility, so sample results for point to point can be compared.

Hollow, hardened steel probes equipped with either a reusable or expendable drive tips, are driven into the ground. Soil vapor is then drawn from the ground through a flexible Teflon tubing inside the probe using an applied vacuum. Soil vapor can then be collected in a Tedlar bag and analyzed using a portable GC to estimate the concentration of volatile contaminants in the soil vapor. Refer to Appendix F for details on the sample collection procedure. Soil vapor sampling equipment will be decontaminated following the procedures outlined in Appendix G.

2.5.2.13. VOC Surface Flux (Flux Chamber)(Contingent). Flux test procedures can be found in the following documentation:

Flux chamber tests	Appendix E and EPA/600/8-86/008 (EPA 1986b)
GC operational procedures	Appendix A
GC calibration	Appendix A and Section 1.6.1 of this SAP

2.5.2.14 Soil Moisture Measurements (Contingent). Neutron thermalization depends upon the ability of hydrogen to slow fast neutrons. A fast neutron source (50 mCi americium-241/beryllium) is lowered down a neutron access tube. The fast neutrons are slowed by the hydrogen in the water, and the resultant slow neutrons are counted by a detector. The count can then be correlated with moisture content. Additional details for these procedures are located in Appendix P of this SAP.

2.5.3. Decontamination. Decontamination procedures are outlined in Appendix G, (ETSOP-47) and in the *EG&G Idaho Radiological Controls Manual*, Chapter 4, Section 3.6.

2.6 Sample Handling and Analysis

2.6.1 Sample Containers and Preservation

Vapor samples:

- 1-L Tedlar bags, keep out of sunlight, avoid internal condensation. Holding time: Analyze as soon as possible, optimally within 1 week.
- 540-mL plastic bottle for radiological screening (150 ml minimum). Concentrated nitric acid and preservative to pH<2. No established holding time.
- (2) 40-mL glass vials for VOCs. Keep at 4°C. Holding time is 14 days.

Water samples (in collection priority):

- 125 ml plastic for gross alpha beta.
- 1-L plastic bottle for metals. Concentrated nitric acid required as a preservative, <2 pH. To ensure a pH of <2 has been reached, place a strip of pH paper in the bottle after preservation. Determine the pH by comparing the color of the paper to the template. Keep at 4°C. Holding time is 6 months.
- 1000 ml amber glass for semivolatiles, keep at 4°C.
- 125 ml glass for anions, keep at 4°C

2.6.2 Packaging, Labeling and Shipping

Samples will packaged, labeled, and shipped using ETSOP-52, Appendix D, which follows the requirements set forth in *EG&G Idaho Company Procedures Manual*, Section 14.1, "Onsite Transportation of Hazardous Materials."

2.6.3 Documentation

All documentation will be in accordance with ERD PD 4.1 "Document Control" (Appendix L). A copy of the following documentation will be forwarded to the EG&G Idaho ERD ARDC upon completion of the project:

- **Chain-of-custody.** Samples for off site analysis must be labeled and handled according to standard custody procedures as necessary to ensure the project objectives are fulfilled. These procedures will be in accordance with ERD PD 5.7, "Chain-of-Custody Record."

- **Field logbooks.** Field activities must be recorded with indelible ink in the appropriate field logbook. The use of logbooks will be in accordance with ERD PD 4.2, "Logbooks."

- **Portable GC data.** Data files, including calibration files, will be recorded on 3-1/2-in. disks.

- **Laboratory data.** Analytical results from laboratories must be reported in accordance with the subcontract SOW for that laboratory. Analytical data produced for the requested analyses will be reported to Donna Kirchner of EG&G Idaho, Environmental Restoration Department, P.O. Box 1625, Idaho Falls, ID 83415-1403, telephone (208) 526-9873.

  Data must be reported for *all* samples submitted for laboratory analysis and should include all QA/QC and raw data.

- **Final data.** A report incorporating the sample data will be issued to the project manager upon completion of data evaluation by the EG&G Idaho Environmental Technology Unit.

- **Training.** Pre-job briefings and personnel training sessions will be documented in the FTL's logbook. Records of training will be reported to the employees safety training representative and filed in the individual training files.

2.7 Waste Management

Radiological activity, other than naturally occurring background, was not found in the extraction gases during the operation of VVE in the past and is not expected to be present in future gas samples. Water removed from the perched water zone has the potential to be radiologically contaminated and should be treated as such until the health physics technician has measured activity in the water.

2.7.1 Identification/Generation

Depending on the ultimate packer system designed, the packers may or may not be disposable. If the packers are not disposable, waste will be generated from the decontamination of this equipment between wells. Waste will be generated from the decontamination of equipment, drill cuttings, and purge water from well sampling. Decontamination waste will also be produced during near surface sampling. Other potential waste includes paper towels and gloves.

2.7.2 Minimization

See Appendix R for waste minimization plan.

2.7.3 Disposal

Onsite

Purge water/soil cuttings. Purge water from water sampling and soil cuttings from augering will be contained in 55-gal polyethylene barrels in Building WMF-602 until sampling is completed. The barrels will not freeze in this location. The barrels will be marked with the following:

> PURGE WATER FROM WELL SAMPLING IN SDA (OCVZ) PROJECT or SOIL CUTTINGS FROM AUGERING IN SDA (<1.000 dpm/100 cm^2 beta-gamma, no detectable alpha)
>
> Contacts: Gretchen Matthern, Project Manager, 526-8747
> Joel Hubbell, FTL, 526-1747
> Terry Arrington, JSS, 526-2364

When sampling is completed, samples of the water and soil will be collected for radiological (gross alpha and gamma spectroscopy and chemical (total metals, total organics) analyses. Ultimate disposal and further toxicity characteristic leaching procedure analysis will be dependent on the results of these analyses and will be the responsibility of the ERP project manager or designee.

Decontamination liquids. All sampling equipment will be cleaned first with nonphosphorous soap, then rinsed with tap water and deionized water. The equipment will then be wiped with a paper wipe that has been wetted with isopropanol. The wipe will be used until dry, eliminating potential hazardous waste generation from the isopropanol. A 50-mL sample will be collected of the wash water, dried, and measured for alpha and beta-gamma radioactivity. The wipes will also be surveyed for radioactivity using hand-held instrumentation. All radioactivity measurements will be performed by a certified HP. If the water and wipes are determined to be clean, they will be disposed of as sanitary waste. If the water and/or wipes are found to contain radiological contamination, the RWMC environmental engineer and RWMC radiological engineer will be notified for disposal.

Offsite

If decontamination water, purge water, or soil cuttings are found to be hazardous (by RCRA), they will be disposed of using approved disposal procedures. Disposal compliance will be the responsibility of the project manager. (Refer to the health and safety plan (EG&G Idaho 1992b) for proper disposal procedures.)

2.8 Schedule

A schedule of activities is provided in Table 2-3. See Section 2.4 for the frequency of each task.

Table 2-3. Schedule of sampling and analysis activities.

Activity	Start	Finish
Approved SAP/QA	N/A	June 1992
Field sampling		
Perched water	July 1992	August 1992
Soil moisture (contingent)	N/A	N/A
Soil VOC/temperature	July 1992	August 1992
VOC surface flux (contingent)	N/A	N/A
Vapor port permeability	July 1992	August 1992
Basalt tracer	July 1992	August 1992
Meteorological data	July 1992	August 1992
Vapor port monitoring	July 1992	August 1992
Downhole barometric pressure	July 1992	August 1992
Open well vapor sampling	July 1992	August 1992

3. References

3. REFERENCES

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APPENDIX A

Gas Chromatograph Operating Procedures

APPENDIX A

Contents

Appendix A, Part 1
Scentograph
Operator's Manual

SCENTOGRAPH
OPERATOR'S MANUAL

NOTE : Due to United States Nuclear Regulatory Commission regulations, the **SCENTOGRAPH** oven, which contains a sealed radioactive source, should not be repaired by unauthorized personnel, except for changing of the column. At no time should the detector cover be removed unless the person is authorized to do so by **SENTEX SENSING TECHNOLOGY, INC. SENTEX** should be responsible for any maintenance, repair, replacement, or disposal of the radioactive source or any part of the detector.

SENTEX SENSING TECHNOLOGY, INC.
553 BROAD AVENUE
RIDGEFIELD, NEW JERSEY 07657
(201) 945-3694
FAX (201) 941-6064

REVISED 7/90

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APPENDIXES

A. INTRODUCTION

The SCENTOGRAPH is a portable gas chromatograph designed specifically to complete an entire analysis without the need for additional equipment usually required for interpretation of the results.

Computer operated, the SCENTOGRAPH performs automatically the following functions:

- Sample concentration
- Sample injection
- Chromatographic separation and detection
- Peak identification and integration
- Automatic display of chromatograms, retention times, concentration levels and operating conditions
- Automatic, unattended, repeating analysis
- Automatic recalibration at a preselected frequency

The SCENTOGRAPH performs in two operational modes :

CALIBRATION ANALYSIS Mode in which the SCENTOGRAPH uses an internal or external calibration mixture for analysis. During this mode, the SCENTOGRAPH displays the calibration chromatogram, the name, concentration level, and retention time of each compound in the calibration mixture. It also integrates the area under the peaks and assigns a predetermined concentration level to this area.

SAMPLE ANALYSIS: Mode in which the SCENTOGRAPH uses an ambient air, head space, or liquid sample for analysis. During this mode, the SCENTOGRAPH displays the analysis chromatogram above the calibration chromatogram and lists the names, concentration levels, and retention times of the compounds which match the compounds identified during **CALIBRATION.** Compounds detected which do not match compounds identified during **CALIBRATION** are listed as "UNKNOWN". Their retention times and concentration levels, as compared to the first calibration peak, are also displayed. The "UNKNOWN" compounds can be identified by computerized methods in which the **SAMPLE ANALYSIS** results will be matched with other **CALIBRATION** results stored in the SCENTOGRAPH memory or by screening various compound libraries in which hundreds of compounds can be listed. Since both modes operate under the same conditions, and **CALIBRATIONS** can be activated as frequently as required, analytical results obtained by the SCENTOGRAPH are highly reliable and accurate.

The SCENTOGRAPH is completely self-contained and will operate from its own gas supply and battery power for several hours. It utilizes a portable lap-top computer to control its operation, data processing and storage of all chromatograms. The computer is detachable from the SCENTOGRAPH for remote analysis review, hard copy printout, and operation of other MS-DOS programs. The SCENTOGRAPH can function unattended, perform analysis periodically, and calibrate at a chosen frequency with results automatically stored on disk for later review.

B. GETTING STARTED

When you receive your SCENTOGRAPH, carefully unpack all of the boxes and check items received against the packing list. If there are any discrepancies, notify SENTEX immediately.

Prior to operating the SCENTOGRAPH, both the instrument and computer batteries must be fully charged. Plug the instrument charger and the computer charger into their respective jacks and allow the batteries to charge overnight. See battery charging instructions for further information.

Fill the SCENTOGRAPH with carrier gas prior to operation. HP (High Purity - 99.995%) ARGON gas is needed for operation of the Argon Ionization Detector and the combination Argon Ionization / Electron Capture Detector. If the SCENTOGRAPH is equipped with the Photo Ionization Detector or the Thermal Conductivity Detector, HP Helium (99.995%) must be used for proper instrument operation. Use of lesser quality gas will effect the operation of the instrument and cause contamination requiring factory repair. To fill the internal carrier gas tank, follow the directions in Appendix A. After filling the internal tank and disconnecting the fill tubing, turn the internal tank valve to the horizontal, or 'ON' position.

With the batteries charged and the internal carrier gas cylinder filled with gas, the SCENTOGRAPH is ready to be turned on and operated. The instrument is started by switching the computer on. The computer will automatically load the operating program and initiate operation of the SCENTOGRAPH.

When the Operating Menu appears, press '1' and then press **<ENTER>**. This will display the Operating Parameters Screen. The current parameters are from the Quality Control Check performed at SENTEX. These parameters operate the SCENTOGRAPH for the compounds listed in Peak Information parameter settings (choice 14). These are general settings and will be helpful in analysis of many compounds other than those identified.

To observe the current oven temperature, press **<ENTER>** to return to the Operating Menu Screen. Press **'7'** and **<ENTER>** to go to the Utility Menu Screen. Enter **'3'** to display the current oven temperature. The Oven Temperature screen displays two readings. The upper reading represents the Analog/Digital data from the SCENTOGRAPH main board while the lower reading is the actual oven temperature in degrees centigrade.

Press **<ENTER>** to return to the Utility Menu. Press **<ENTER>** a second time to return to the Operation Menu Screen. If the internal calibration cylinder contains calibration gas, a calibration can be run by pressing **'4'** and **<ENTER>**. If there is no gas in the internal calibration cylinder, refer to APPENDIX A for charging the internal cylinder or APPENDIX B for calibrating the SCENTOGRAPH from an external source. The PC will show the chromatograph screen with the operating information and the calibration trace displayed. After the completion of the calibration, press any key to return to the Operating Menu. At this point, another calibration can be run, an analysis can be run or data can be reviewed. To fill the SCENTOGRAPH with calibration gas or to run an external calibration, see the appropriate sections in the manual for complete instructions.

C. RADIOACTIVE SOURCE

The Argon Ionization and Electron Capture Detectors in the SCENTOGRAPH contain a radioactive isotope of Hydrogen 3 with an activity level of less than 150 millicuries and a half-life of 12 years. Or, the detector may contain a Nickel-63 source with an activity level of less than 15 millicuries and a half-life of about 85 years. These sources are not accessible. They are sealed within a stainless steel cylinder and located within the detector cavity. If the isotope is Hydrogen 3, no wipe or leak test is required. If the isotope is Nickel-63, a wipe or leak test is required at 3 year intervals. The oven temperature should not be set above 180 deg. C. If the oven temperature should rise above 180 deg. C., a safety circuit will automatically turn the heater power off. If the safety circuit should malfunction, the heating element itself will deactivate at 200 deg. C. If this should occur, a hardware problem exists in the SCENTOGRAPH and SENTEX should be consulted. No repair of the detector cell should be performed. If the detector cell exhibits no electronic signal and baseline current is zero, the isotope may require replacement. SENTEX should be contacted for repair of the detector cell or replacement of the isotope. You should arrange for SENTEX or other specifically licensed person to perform the required wipe or leak test at 3 year intervals or to dispose of the radioactive material when no longer needed. If damage to the detector cell occurs, please notify your Radiation Safety

Officer or SENTEX SENSING TECHNOLOGY, INC., 553 Broad Avenue, Ridgefield, NJ 07657 - (201) 945-3694 or fax (201) 941-6064. Possession and use of the radioactive source (H-3 or Ni-63) in the instrument is authorized by the U.S. Nuclear Regulator Commission under either a specific license or a general license. A copy of the general license (Section S31.5 of U.S. NRC regulations) accompanied SENTEX's transfer of this instrument. The simple safety requirements of the specific license or general license are designed to protect you as a user and the public from unnecessary exposure to radiation. Users should follow those requirements.

DETECTOR CLEANING

1) Cleaning of the detector will be performed only by SENTEX personnel or by other persons authorized and trained by the Company.

2) Detectors containing H-3 foils when contaminated, should be sent to the Company for foil replacement. Replacement procedure is similar to installation procedure.

titanium tritide

3) Detectors containing Ni-63 will generally be sent to the Company for cleaning unless otherwise instructed by the Company.

4) Detectors containing Ni-63 will be cleaned by removing the detector cover and washing the foil with Acetone several times. The foil is <u>not</u> to be removed from the detector.

5) If customer is authorized to clean the detector, he will be provided with a special tool to remove the detector cover. The customer should be trained by the Company before being authorized for detector cleaning.

6) Detector cleaning procedure will be carried out as follows:

- A) Wear polyethylene gloves.
- B) Remove detector cell from instrument.
- C) Remove detector cap.
- D) Immerse detector in a beaker containing Acetone for 30 minutes and shake periodically.
- E) Remove detector from solvent and let dry.
- F) Replace the cover and reinstall the detector.
- G) Discard gloves and solvent.

D. SCENTOGRAPH SYSTEM DESCRIPTION

The SCENTOGRAPH consists of the following components:

I. OVEN ASSEMBLY

This includes the oven, the column, the detector and if installed, the injection port. The column and injection port fit in the larger of the two oven compartments while the detector fits in the smaller oven compartment. Packed columns of 1/8" diameter and up to 15 feet in length, or capillary columns of up to 30 meters in length, can be utilized. The column and detector oven can be heated from ambient to 180 degrees C for both isothermal and temperature programmed analysis.

(A) DETECTORS

The SCENTOGRAPH is equipped with **one** of these four detectors:

(A-1) **Micro Argon Ionization/Electron Capture Detector** - Both a Micro Argon Ionization Detector and an Electron Capture Detector are combined in one detector assembly. Changing from one detector to the other requires only the change of electronic switches. This detector, which offers two detectors in one assembly, has the following sensitivity:

MAID Mode - 1 PPB toward hydrocarbons (Benzene)

ECD Mode - Parts Per Trillion levels (SF^6)

(A-1.1) MICRO ARGON IONIZATION DETECTOR

This detector is suitable for the detection of most organic compounds. Its simplicity and ruggedness make it ideal for field use. This detector, coupled with a vapor preconcentrator, enables the SCENTOGRAPH to detect 50 parts per billion (PPB) levels. PPM levels and above can be detected by a 1 cc. syringe injection or a sample loop in place of the preconcentrator. This detector operates on the following principle:

When Argon flows over Tritium (H-3), the following reaction occurs:

A → A* (Energized to the Excited State)

Part of the Argon atoms are energized to the "Excited State" and part of them are ionized. The excitation energy of Argon is approximately 11.6 EV. Accordingly, when Argon enters a detector containing Tritium, a steady state of Energized Argon Atoms (Exitons) is developed. When organic molecules are introduced to the detector, they collide with the "Exitons". Since the Ionization potential of most organic compounds is less than 11.6 EV, the results of this interaction are:

A* (Exiton) + R (Organic molecule) → A + R^{+} + e^{-}

which indicates ionization of the organic molecule has occurred. This reaction produces positive and negative charges in the detector cell and, if high voltage is supplied to the detector, an increase in current develops. This current is amplified and measured.

(A-1.2) MICRO ELECTRON CAPTURE DETECTOR

The Electron Capture Detector is a highly sensitive detector which is selective to compounds capable of capturing electrons, such as Halogenated and Nitro compounds only. The Electron Capture Detector operates on the following principle:

When Argon, Helium, or Hydrogen is flowing through the detector and over Tritium (H-3), the following reaction occurs: $A \rightarrow A^+ + e^-$

When low voltage is applied to the detector, the current produced is called the standing current. When a compound which has an affinity for electrons, such as a halogenated, organic compound enters the detector, the following reaction develops:

$R\text{-}Cl + (A + e^-) \rightarrow (R\text{-}Cl + e^-) + A^+$

(R-Cl is a Halogenated Compound)

The above reaction indicates the compound "captured" the electron, and became a negative ion. The light, fast moving electron is transformed into a large, slow moving negative ion. With low voltage supplied to the detector, the mobility of the negative ion is decreased with a decrease in the number of negative charges reaching the electrode. A reduction in current develops, which can be amplified and measured.

(A-3) PHOTOIONIZATION DETECTOR

The Photoionization Detector operates on the principle of ionization of organic compounds by an ultraviolet (UV) source. UV lamps with different energy levels are available. A UV source with 10 electron volts (EV) can ionize all compounds which have an ionization potential below that level. The highest energy derived from UV lamps is 11.8 EV, which is sufficient to detect most organic compounds. Due to unreliable performances of the lamp generating 11.8 EV, however, the most commonly used source is the 10.6 EV, which can ionize many of the organic compounds. Some compounds such as Chloroform and Trichloroethane, which have higher ionization potential are not well detected. The carrier gas enters the detector cell which is exposed to the UV source. If an organic compound enters into the detector cell, it will immediately be ionized by the UV source, thereby generating ions and electrons. By applying voltage to the detector cell, current is developed, which can be measured. Helium, Ultra High Purity, is the recommended carrier gas.

(A-4) THERMAL CONDUCTIVITY DETECTOR

This detector, although not sensitive, responds to natural gases, including Methane and Oxygen, which cannot be detected by other detectors. It operates on the basis of the difference in thermal conductivity of a hot wire when gases flow across the wire. High Purity Helium is the recommended carrier gas for this detector. The Thermal Conductivity Detector can normally detect analysis concentration levels as low as 100 PPM. The TCD is capable of percent level analysis of many gases.

(B) HEATED INJECTION PORT

The SCENTOGRAPH can be equipped with a heated on-column septum injection port (OPTIONAL) for syringe injection of gas or liquids. The Heated Injection port is located inside the column oven. Direct injection of gas samples will allow sensitivities similar to using a sample loop (PPM range for a 1 cc injection). Injection of liquid samples is limited to a 1 to 2 μl (micro liter) injection size. The SCENTOGRAPH can easily determine PPM concentrations and lower from liquid sample injections. The accuracy and reproducibility of the SCENTO-

GRAPH when syringe injections are utilized is directly influenced by the injection technique of the operator.

(C) COLUMNS

The SCENTOGRAPH can be equipped with a single column either 1/8" packed or capillary. The 1/8" columns are packed with a choice of standard packings as offered by column packing manufacturers. The columns are packed in either aluminum or teflon, both of which is specially pre-treated for superior resolution and separation capabilities. The oven is designed to accommodate fused silica capillary columns of up to 30 meters in length, The standard length is 10 meters. Both polar and non-polar capillary columns are offered as options to cover the vast range of compound separation requirements.

II. SAMPLE COLLECTION SYSTEM

PRECONCENTRATOR OR SAMPLING LOOP

The SCENTOGRAPH is normally equipped with a preconcentrator packed with Tenax, an absorbent material. Dependent on the users application, Carbosieve can be substituted as the absorbent material. The preconcentrator is used when sample concentrations are 50 PPM and below. An optional sample loop can be installed in place of the preconcentrator. The sample loop is utilized when fixed volume injections are required (normally 0.5 or 1.0 cc sample size). If sample concentrations are expected to exceed 50 PPM, a sample loop should be utilized. The sample loop permits analysis of sample concentrations between 1 PPM and 1000 PPM of most compounds.

NOTE: ADJUSTMENT OR REPLACEMENT OF THE PRECONCENTRATOR WITHOUT MANUFACTURER'S INSTRUCTIONS MAY DAMAGE THE INSTRUMENT AND VOID MANUFACTURER'S WARRANTY

The sample can be introduced to the preconcentrator or sampling loop from the following inputs:

(A) INTERNAL CALIBRATION CYLINDER

Calibration gas may be introduced into the internal calibration cylinder and then used for calibration of the SCENTOGRAPH. See APPENDIX A.

(B) EXTERNAL CALIBRATION PORT

The Calibration Port, located on the right side of the SCENTOGRAPH, is used to calibrate from a sampling bag, head-space of an external container or other external source.

NOTE: EXTERNAL SAMPLES MUST BE TAKEN AT AMBIENT PRESSURE. PRESSURE HIGHER THAN AMBIENT WILL CAUSE INTERNAL VALVES TO MALFUNCTION.

(C) ANALYZE PORT

The Analyze Port, located on the right side of the SCENTOGRAPH, is used to sample air from the environment or from an enclosed source. When a sample bag is utilized for analysis, the bag is attached to the external ANALYZE port with the teflon tube supplied in the start-up kit. The SCENTOGRAPH is equipped with an automatic sampling pump with intake of approximately 80 cc per minute.

III. CARRIER GAS CYLINDER AND REGULATOR

This internal cylinder should be filled with Argon (HP Grade - 99.995%) for the ARGON IONIZATION/ELECTRON CAPTURE DETECTOR or Helium (HP Grade - 99.995%) for the ECD, PID, OR TCD. The cylinder is easily refilled. The internal carrier gas cylinder is operated from the carrier gas valve located on the rear of the SCENTOGRAPH. The internal carrier gas cylinder supplies high pressure carrier gas to the carrier gas regulator where the pressure is reduced to the operating column pressure. The carrier gas regulator is located to the left of the pressure gauge panel. The column pressure is adjusted by turning the Allen screw on the top of the carrier gas regulator. Clockwise increases column pressure, counterclockwise decreases column pressure.

IV. CALIBRATION GAS CYLINDER AND REGULATOR

This internal cylinder contains the calibration gas, as determined by the SCENTOGRAPH user. The calibration cylinder is easily refillable and when filled, will provide a minimum of eight hours supply of calibration gas. Up to 16 compounds can be identified in the calibration gas mixture at any one time. The calibration gas cylinder supplies high pressure calibration gas to the calibration gas regulator, located left of the carrier gas regulator. The calibration gas regulator reduces the high pressure to the required low pressure necessary for instrument calibration.

V. PRINTED CIRCUIT BOARDS

The SCENTOGRAPH contains two Printed Circuit Boards:

1) Main Board (Figures 20 and 21)

2) High Voltage Board (Figure 19)

The Main board is located under the PC. The High Voltage Board is located on the High Voltage Board Stand next to the Oven Assembly. When the cover is lifted on the SCENTOGRAPH, care must be taken to prevent objects from touching the circuit boards. Metal or other conductive materials could possibly cause a short circuit by touching any of the electrical leads on the circuit boards.

VI. SCENTOGRAPH INSTRUMENT BATTERIES

Four lead-acid, 6-volt, 6 Amp hour rechargeable batteries are used. The batteries must be recharged after each portable operation or on a regular basis if the instrument is not in use. For prolonged high temperature operation, an external battery pack or a heavy duty charger is required.

NOTE: FOR FIXED LOCATION OPERATION, THE INSTRUMENT SHOULD BE OPERATED FROM THE BATTERY CHARGER IF 110V ELECTRICAL SOURCE IS AVAILABLE.

NOTE: FOR FIXED LOCATION OPERATION WITH OVEN TEMPERATURE IN EXCESS OF 120° C, AN 8 AMP BATTERY CHARGER IS REQUIRED.

NOTE: FOR PORTABLE OPERATION WITH OVEN TEMPERATURE IN EXCESS OF 120° C, A HEAVY DUTY BATTERY PACK IS REQUIRED.

VII. LAP-TOP COMPUTER

The SCENTOGRAPH is equipped with a detachable lap-top Personal Computer (PC). The PC features 640K bytes of Random Access Memory and two 3-1/2 inch 720K disk drives. Please refer to PC USER'S MANUAL for more complete information. The SCENTOGRAPH PLUS is provided with a PC equipped with 1 Megabyte of RAM, a 20 megabyte hard disk drive and one 3-1/2 720K inch disk drive.

NOTE: THE PC BATTERY IS CHARGED BY ITS OWN BATTERY CHARGER. PLEASE REFER TO THE PC MANUAL FOR PROPER CHARGING INSTRUCTIONS. THE PC CONTAINS A NiCad BATTERY AND REQUIRES SPECIAL CHARGING CARE TO AVOID BATTERY MEMORY.

VIII. SCENTOGRAPH SOFTWARE

The software program which operates the SCENTOGRAPH (SNX.EXE) is contained on the "A" disk of the PC, which accompanies the SCENTOGRAPH. Data can be stored on either the "A" or the "B" disk. In the SCENTOGRAPH PLUS, the program is loaded on the hard drive while the data can be stored on the hard drive or the "A" disk.

The SCENTOGRAPH operating software is written in the language of 'C' and can run on most IBM compatible machines using MS-DOS Version 2.1 and higher. The program can be copied and used on other computers to review SCENTOGRAPH results while the original program is operating the SCENTOGRAPH. A good practice is to make a back-up copy of the program disk for storage in a safe location. The back-up copy can be used to operate the SCENTOGRAPH if something should happen to the original copy of the program.

IX. CONTROLS AND DISPLAYS

The SCENTOGRAPH has the following controls and displays:

A. SWITCHES

PC ON/OFF: This switch is located on the PC. Switching the PC "ON" will automatically activate the SCENTOGRAPH. The cover of the SCENTOGRAPH must be unscrewed and lifted to access this switch. Dependent on the computer provided with the SCENTOGRAPH, the switch will be located on the back panel of the computer or one of the side panels.

B. KEYBOARD

The PC keyboard is used to operate the SCENTOGRAPH, to recall and display chromatograph summaries, and to alter various parameters used during CALIBRATION and ANALYSIS.

C. DISPLAY

The PC LCD monitor displays all the parameters, data and chromatograms obtained during operation.

D. PRESSURE GAUGES

Three pressure gauges are located on the front panel of the instrument. They indicate the status of the calibration gas cylinder, the carrier gas cylinder, and the column pressure. Maximum pressure for the calibration and the carrier gas cylinder is 1800 PSI. Pressure of 200 PSI or lower on either gauge indicates the corresponding cylinder needs to be refilled. The column pressure indicates the carrier gas pressure at the front of the chromatographic column. Normal column operating pressure range is between 10 and 30 PSI.

NOTE: DAMAGE MAY OCCUR IF THE SCENTOGRAPH IS OPERATED WITH CARRIER GAS OR CALIBRATION GAS PRESSURE GREATER THAN 1800 PSI.

E. PRESSURE REGULATORS

(i). Column Pressure Regulator:

The Column Pressure Regulator is located under the SCENTOGRAPH cover next to the gauge panel. Use the Allen Key (supplied with the instrument) to change column pressure. Turning the Allen Key clockwise will increase pressure; counterclockwise will decrease pressure.

NOTE: OPERATING THE SCENTOGRAPH WHILE COLUMN PRESSURE IS BELOW 5 PSI OR ABOVE 30 PSI MAY DAMAGE THE COLUMN. SCENTOGRAPH COLUMN PRESSURE SHOULD NOT EXCEED 30 PSI.

(ii). Calibration Pressure Regulator:

The Calibration Pressure Regulator is located under the SCENTOGRAPH cover to the left of the Column Pressure Regulator. FOR ADJUSTMENT, PLEASE SEE APPENDIX.

F. UTILITY PANEL CONTROLS

The Utility Panel of the instrument, located on the back of the SCENTOGRAPH has the following controls:

(i) CARRIER GAS VALVE AND INLET

The inlet to the internal carrier gas cylinder and the cylinder are located on the Back Panel.

NOTE: HIGH PURITY CARRIER GAS MUST BE UTILIZED. IT IS VERY IMPORTANT NOT TO CONFUSE THE TWO INLETS. WHEN FILLING THE CARRIER GAS, ENSURE THAT THE CARRIER GAS INPUT IS USED. WHEN FILLING CALIBRATION GAS MAKE SURE THE CALIBRATION INLET IS USED. FILLING CALIBRATION GAS INTO THE CARRIER SYSTEM WILL CONTAMINATE THE SYSTEM, REQUIRING FACTORY REPAIR.

(ii) CALIBRATION GAS VALVE AND INLET

The inlet to the internal calibration gas cylinder and the valve of this cylinder are located on the rear panel of the instrument.

(iii) BATTERY CHARGER INPUT

A battery charger must be plugged to the instrument to re charge the internal batteries after portable use or on a regular basis if the SCENTOGRAPH is not in use.

NOTE: INTERNAL BATTERIES MUST BE RECHARGED AFTER PORTABLE INSTRUMENT OPERATION OR DURING INSTRUMENT STORAGE.

(iv). COMPUTER CHARGER INPUT

The PC charger should be connected to the input located on the Back Panel of the SCENTOGRAPH. The low BATTERY light on the face of the PC will indicate when recharging is necessary. Please refer to the USER'S MANUAL, which accompanies the PC for more information.

E. SCENTOGRAPH PROGRAM PARAMETERS

Upon start-up of the PC, the title screen will be displayed as shown in Figure 1. This will be displayed while the program is loading. The PC will automatically turn the SCENTOGRAPH on and display the OPERATION MENU as shown in Figure 2. If the PC is not connected to the SCENTOGRAPH, the message, as illustrated in Figure 3-A, will appear before the OPERATION MENU is displayed and the COMM FAILURE (communications failure) status will be indicated on the screen as in Figure 3-B. If communication failure occurs, please check the interface cable connection between the SCENTOGRAPH and the PC and restart the computer. The OPERATING MENU has the following functions:

I. OPERATING PARAMETERS

In order to review or change OPERATING PARAMETERS, Press "1" and then <**ENTER**> and the OPERATING PARAMETERS screen will be displayed as illustrated in Figure 4. To change an OPERATING PARAMETER, type the Parameter number, press <ENTER>, type the change required, and press <ENTER>.

The OPERATING PARAMETERS and their functions are as follows:

1. CALIBRANT

This parameter is for information only and will not affect the operation of the SCENTOGRAPH. Enter any name (up to 12 characters long) to identify the calibration mixture you are using. This name will be displayed on each calibration trace until it is changed.

2. SAMPLE TIME (0-999 sec.)

This is the time during which the internal pump in the SCENTOGRAPH will draw a sample from either the CALIBRATION or ANALYSIS inlet port.

A. SCENTOGRAPH EQUIPPED WITH A PRECONCENTRATOR:

The sample time determines the amount of sample which passes through the preconcentrator for adsorption. It is recommended that for CALIBRATION or ANALYSIS of samples with concentrations between 0.1 and 10 ppm, the sampling time should be 10 seconds. Sampling time should be increased for concentration levels below 0.1 ppm and decreased for samples with concentrations over 10 ppm. The preconcentrator should not be used when sample concentrations exceed 50 ppm. This level of concentration will overload the preconcentrator, causing carry over and preconcentrator contamination.

B. SCENTOGRAPH EQUIPPED WITH SAMPLE LOOP

The sampling time determines the amount of sample purged through the sample loop. The sample loop requires minimum of 5 seconds sampling time to purge the loop with a fresh sample. The sample loop provides the SCENTOGRAPH with a repeatable, fixed volume injection for each calibration and analysis sample. The sample loop size is normally 0.5 to 1 cc. and provides the SCENTOGRAPH with a sensitivity in the PPM range for Benzene. The sample loop permits the sample concentration to be as high as 5000 PPM (loop size 0.1 cc) without contaminating the GC system with excessive sample.

C. <u>SCENTOGRAPH EQUIPPED WITH INJECTION PORT</u>

The preconcentrator or sample loop is not used when introducing a sample into the SCENTOGRAPH via direct syringe injection. When using syringe injections, the sample time must be set to zero. When the injection port is being used, sampling time should be turned to 0. The system automatically changes the delay time and the desorption time (the next two parameters) to 0. When changing from liquid injection procedure to either sampling loop or preconcentration operation, parameters 2, 3 and 4 should be reprogrammed. See APPENDIX J for use of INJECTION PORT.

3. <u>DELAY TIME (0.0-2.0 sec.)</u>

During this time, the preconcentrator is purged with carrier gas. If the SCENTOGRAPH is equipped with a sample loop or when syringe injection is used, DELAY TIME should be set at 0 seconds. It is recommended that when the SCENTOGRAPH is equipped with a preconcentrator, the DELAY TIME should be 0.5 seconds. When the PURGE AND TRAP SYSTEM is used for sample collection, delay time should be increased to 2.0 seconds.

4. DESORPTION TIME (0.0-4.0 sec.)

DESORPTION TIME is the time when the filament is activated to thermally desorb the sample collected in the preconcentrator. If the SCENTOGRAPH is equipped with a sample loop or when syringe injection is used, DESORPTION TIME should be set at 0. It is recommended that for a SCENTOGRAPH equipped with a preconcentrator, the DESORPTION TIME should be set to 4 seconds.

5. INHIBIT TIME (0-999 sec.)

This is the time when the sample is initially being processed through the column, without chromatographic display. Inhibit time is used to eliminate undesired injection peaks. For most columns, inhibit time is set to 30 seconds. Inhibit time for liquid injection should be set at 0. Inhibit time for use with injection loop or gas injection should be set at 60.

6. OVEN TEMPERATURE (30° to 180° Centigrade)

The value chosen will determine the oven temperature. Temperature can be altered in increments of one degree. Oven temperature is changed to effect the resolution of sample peaks in the chromatogram. For most columns, when the temperature is raised, the compounds elute faster from the column, bringing the sample peaks closer together towards the beginning of the trace. When the temperature is lowered, the elution rate is slowed, spreading the peaks further apart and increasing the time required for the elution of all of the sample peaks.

NOTE: OPERATING THE SCENTOGRAPH OVEN TEMPERATURE OVER 120° C REQUIRES AN 8-AMP BATTERY CHARGE OR EXTERNAL FIELD BATTERY PACK FOR PORTABLE OPERATION.

7. CHART DURATION (1-40 minutes)

This value indicates the total time, in minutes, during which the chromatograph will be traced on the PC screen.

8. ANALYSIS PER CALIBRATION (1-99 cycles)

This value determines the number of ANALYSIS samples the SCENTOGRAPH will automatically take between calibration samples, when operating in the automatic mode. This value only affects SCENTOGRAPH operation in the automatic mode. This value effects operation when the SCENTOGRAPH is started in the automatic mode during initialization of the program or if automatic operation is initiated through choice '2' of the OPERATION MENU.

9. AUTO ANALYSIS DURATION (0-999 minutes)

This denotes the frequency of ANALYSIS cycles, in minutes, during automatic operation. An entry of 0 indicates the SCENTOGRAPH will operate manually, as indicated by the word "MANUAL" which appears after an entry of 0. The analysis cycle consists of the sample time, the delay time, the desorbtion time, the inhibit time and the chart time. An AUTO ANALYSIS DURATION time of 30 minutes will initiate a new analysis cycle every 30 minutes until SCENTOGRAPH operation is halted by the operator. This will be either a calibration analysis or a sample analysis dependent on the setting of the ANALYSIS PER CALIBRATION parameter.

NOTE : THE SCENTOGRAPH WILL NOT START AN ANALYSIS CYCLE UNTIL THE PREVIOUS CYCLE HAS FINISHED.

10. BACKFLUSH OPTION (0=OFF 1=ON) **{OPTIONAL}**

The Backflush is an option which must be installed for this parameter to operate. If the Backflush is installed, Press "1"and **<ENTER>** to initiate operation. The Backflush will occur automatically as follows : After every ANALYSIS, the carrier gas will reverse its flow and flush the column. The Backflush of the column will last for the time of Chart Duration plus Inhibit Time plus 60 seconds. At the end of this time, normal flow will resume.

NOTE: IF BACKFLUSH IS ACTIVATED, IT WILL AUTOMATICALLY OCCUR AFTER EVERY ANALYSIS AND CALIBRATION CYCLE. THE BACKFLUSH CYCLE CAN BE INITIATED WITHOUT THE BACKFLUSH INSTALLED. THIS WILL NOT ALTER NORMAL OPERATION OF THE SCENTOGRAPH, OTHER THAN INCLUDE THE BACKFLUSH CYCLE TIME BETWEEN EACH ANALYSIS.

11. DETECTOR

This parameter is for information only and will not affect operation. Enter the name which corresponds to the Detector in operation. (AID, ECD, PID, TCD).

12. COLUMN (Enter up to 12 letters)

This parameter is for information only. Enter the column name so that it will be identified on the chromatogram.

13. NUMBER OF CALIBRATION PEAKS (1-16)

The number of the compounds in the calibration standard, to a maximum of 16, should be recorded. This instructs the program as to the number of calibration peaks it will identify in the calibration analysis. If a value of 2 is entered and a total of 4 peaks are found, only the first two will be identified by the SCENTOGRAPH and saved in the calibration information. The number of peaks entered for the calibration information only affects the number of peaks counted in the calibration analysis. This does not limit the peak identification that occurs during the sample analysis.

14. PEAK INFORMATION

For each calibration compound to be analyzed, identify the following:

NOTE : FOR PROPER IDENTIFICATION OF COMPOUNDS, THE CALIBRATION PEAK INFORMATION MUST BE ENTERED IN THE CORRECT ELUTION ORDER (ORDER IN WHICH COMPOUNDS TRAVEL THROUGH THE COLUMN FROM FASTEST TO SLOWEST). THIS INFORMATION CAN BE OBTAINED THROUGH COMPOUND ANALYSIS, CONTACTING THE CHROMATOGRAPHIC COLUMN MANUFACTURER OR CONTACTING SENTEX.

*PEAK NUMBER - Identify each calibration compound sequentially in the order they will elute from the chromatographic column installed in the SCENTOGRAPH.

*SUBSTANCE NAME - Enter up to 8 letters to identify each compound in the calibration mixture.

*CONCENTRATION RANGE - (PPM = 1   PPB = 0) Enter the number which corresponds to the concentration level of each compound.

*CALIBRATION CONCENTRATION - This is the concentration value of each compound in the calibration mixture. Valid input is between 0.01 and 999999 in the ppm or ppb range. The value entered represents the concentration of each compound in the calibration mixture.

*LOW ALARM LEVEL CONCENTRATION - Identify the level for each compound at which the low level alarm will be activated. The valid range is between 0.01 to the 999999 ppm or ppb. This value represents the concentration level for each compound at which the low level alarm will sound. Each compound may have a different concentration level at which an alarm will activate.

*HIGH ALARM LEVEL CONCENTRATION - Identify a second level for each compound which will activate the alarm. The HIGH ALARM LEVEL CONCENTRATION must be a value greater than the LOW ALARM LEVEL CONCENTRATION for proper operation of the alarms.

For proper SCENTOGRAPH operation, this information must be reported for <u>each compound</u> in the calibration mixture, up to a maximum of 16 compounds.

15. <u>NEXT SCREEN</u>

Enter 15 for additional Operating Parameters. (Figure 5)

17. FINAL TEMPERATURE (30° - 180° C.)

If temperature programming is desired, enter a final temperature (up to 180° C) greater than the Oven Temperature. For isothermal operation, the final temperature should be identical to the Oven Temperature entered in Parameter 6.

NOTE: FINAL TEMPERATURE MUST BE HIGHER THAN OVEN TEMPERATURE FOR TEMPERATURE PROGRAMMING TO OPERATE.

18. TEMPERATURE PROGRAM DURATION

Temperature programming will be carried out by entering the Oven Temperature (parameter 6), the Final Temperature (parameter 17) and Temperature Program Duration (parameter 18). The oven temperature will change, accordingly, every 30 seconds until the final temperature is achieved or the trace is aborted. The time desired for the temperature increase is entered in **SECONDS**, noting that the SCENTOGRAPH is limited to 1 degree Centigrade per 15 seconds.

EXAMPLE : Temperature programming is desired during a 20 minute analysis trace. The initial Oven Temperature is set at 70° C and an increase of 30° C is desired during the first 10 minutes of the trace. Temperature programming parameters are set as follows :

PARAMETER 6. OVEN TEMPERATURE - 70° C

PARAMETER 17. FINAL TEMPERATURE - 100° C

PARAMETER 18. TEMPERATURE PROGRAM DURATION in seconds - 600 seconds (10 minutes expressed in seconds).

The trace will start with an oven temperature of 70° C with the oven temperature immediately starting to climb. The rate of temperature change will be calculated by the computer so that 100° C will be achieved at the 10 minute mark of the trace (as selected by the final temperature parameter and the duration of temperature change parameter). The temperature will then remain constant throughout the remaining 10 minutes of the trace.

NOTE : TEMPERATURE PROGRAM DURATION CANNOT EXCEED 1° C PER 15 SECONDS. THIS IS THE REQUESTED TEMPERATURE CHANGE DIVIDED BY THE TIME DURATION FOR THE CHANGE IN SECONDS.

19. DISPLAY MAGNIFICATION FOR SAMPLE RUNS

The SCENTOGRAPH is equipped with a display magnification of 3.5 orders of magnitude. Enter the magnification desired which will determine the dimensions of the chromatograph display. The display magnification does not affect the sensitivity of the SCENTOGRAPH. The display magnification only changes the Chromatogram screen display. The magnification can be changed during operation to enhance smaller peaks by pressing the + key. Each time the + is pressed, an additional amplification will occur and the monitor will display the current magnification value. To decrease magnification during operation, press the - key and peak size reduction will occur. During operation, changing the magnification will not affect the chromatogram already on the screen. In addition, chromatograms can be reviewed at different magnifications by changing the display value while reviewing a chromatogram. (See Appendix D).

NOTE: RECOMMENDED DISPLAY MAGNIFICATION IS ONE.

20. TIME WEIGHTED AVERAGE (0-24 hours)

TWA is a summary of analysis results averaged over a period of time. Enter the period of time for which the average will be calculated. The TWA option will only function when the SCENTOGRAPH is operating in the automatic mode. The parameter is set, automatic operation is started and the TWA counter starts to track all of the necessary data. When the prescribed period of time has elapsed, The SCENTOGRAPH reviews all of the traces that have accumulated, averages the results, determines the high and low concentration results and develops a report. If the SCENTOGRAPH has a printer attached and active, it will automatically print the report as well as save the data to a text file. If the printer is not attached, the report will only be saved to the text file.

NOTE: THIS PARAMETER WILL OPERATE ONLY IF THE INSTRUMENT IS IN AUTOMATIC MODE.

21. COLUMN PRESSURE

This Parameter is for information only. Enter the column operating pressure as displayed on the Column Pressure Gauge. (For information only).

22. ENABLE/DISABLE ALARM (0-1)

The alarms, as set in PARAMETER 6 - PEAK INFORMATION, are activated by this parameter. If the Enable Alarm is off, the alarms will not effect operation of the SCENTOGRAPH when a sample analysis trace indicates the presence of a calibration compound which exceeds the preset alarm value. With the Alarm Activated, the analysis peak would activate the alarm as indicated by a beep from the computer.

NOTE: FOR OPERATION OF EXTERNAL ALARMS, OPTIONAL ALARM RELAYS MUST BE INSTALLED.

23. ENABLE PRE-PURGE (0-OFF,1-300)

Enter 0 to disable the pre-purge cycle. Enter the desired pre-purge duration time between 1 and 300 seconds to activate the initial purge prior to sampling. This parameter operates the PURGE AND TRAP sampling accessory and does not effect normal operation of the SCENTOGRAPH.

24. COMPOUND DATA BASE NAME

The SCENTOGRAPH program allows the creation of compound databases. A Compound database consists of a list of compounds and their retention times. The information in the compound database is used for identification of unknown compounds in an analysis chromatogram. Up to 10 compound databases can be stored on the floppy diskette containing the operating program. Each database can include up to 100 compounds. Entering the database name will determine which database is to be used in the chromatogram review process. The compound data base name must consist of alpha-numeric characters (0-9 and/or a-Z). Use of periods or spaces will cause naming errors for the data base.

25. COMPOUND DATABASE ENTRY

Enter 24 to establish a data base. The database consists of up to 100 compound entries. Enter the number of the compound to be added or edited. At the screen prompt, enter the compound name and the compound Retention Time. Compound data entered into the each data base should be representative of compound analysis performed under identical conditions, using the same column, the same temperature and the same column pressure. This will ensure proper use of the data during identification of "UNKNOWN" compounds.

26. VIEW DATABASE

Press '**99**'and <**ENTER**> to view data in the compound Database. (See Figure 7).

After all parameters have been introduced, Press <**ENTER**> twice to return to the Operation Menu. The Parameters, as entered, will be automatically saved in the SENTEX.PRM file found on the operating program disk.

II. AUTOMATIC OPERATION

In order to begin automatic operation, Press '**2**'followed by<ENTER> and the SCENTOGRAPH will initiate automatic operation if the Operating Parameters are properly set for automatic operation.

III. ANALYSIS RUN

Press '**3**' followed by <**ENTER**> to initiate a single Sample Analysis. If Parameters have been altered, a Calibration will automatically occur prior to Analysis. Prior to running the analysis, the program will prompt the user for a name to associate with the analysis trace. A name for the analysis run can be introduced at the program prompt.

IV. CALIBRATION RUN

Press '**4**'followed by <**ENTER**> to initiate a single Calibration run.

V. ANALYSIS SUMMARY

Press '**5**' followed by <**ENTER**> to recall a text summary of all analyses and calibrations.

VI. CHROMATOGRAPH REVIEW

Press '**6**' followed by <**ENTER**> to review the chromatograms stored on the Data disk.

VII. UTILITY MENU

Press '7' followed by <ENTER> to proceed to the Utility Menu as displayed in Figure 8. The Utility Menu consists of the following:

1. Set System Defaults

Press '1' followed by <ENTER> to display the system's default parameters. Set System Defaults contains the following utilities (See Figure 9):

1-1. Data Disk

Assign the disk drive where data should be stored. (For example, the SANYO has two floppy disk drives, A drive and B drive. Either disk drive can be chosen to store data. It should be noted that the A drive contains the SCENTOGRAPH operating program and computer operating information. This will limit the amount of disk space available for data storage. For the optional computer with a 20 Meg Hard Drive, data can be stored on the C drive (the hard drive) or the A drive. In the case of the Hard Drive system, the SCENTOGRAPH and computer operating programs are contained on the hard drive and will not limit the space available for data storage on the A floppy disk.

1-2. Analysis Peak Retention Time Tolerance Pct (1-9)

This value determines the "window" opening for peak recognition as a percent of retention time, when analysis peaks are matched with calibration peaks, or when library search is performed. The identification window will be ± the window percent value of the current peak retention time.?

RECOMMENDED: A 3% RETENTION TIME WINDOW IS TYPICALLY USED.

1-3. Analog Data from File or Comm Port (1-2)

This value determines which serial port the SCENTOGRAPH program will use when communicating with the Main Board. When the Lap Top computer supplied with the SCENTOGRAPH is used, the COMM port will be 1. If an external computer is used to operate the SCENTOGRAPH, either COMM 1 or COMM 2 may be used. If the program is to be started without operating the SCENTOGRAPH main board, enter '**F**' to operated the program without communicating with the SCENTOGRAPH (for parameter review, analysis summary review and chromatogram review only). To change operation from the 'F' file mode to COMM port operation, exit to the DOS prompt and enter "SNX 1". This will initiate the COMM port operation in the program.

NOTE: TO INITIATE OPERATION OF THE SCENTOGRAPH USING COMM 1 OR COMM 2 AFTER THE PROGRAM HAS OPERATED IN THE F (FILE) MODE, EXIT TO DOS AND ENTER "SNX 1".

1-4. Noise Threshold (1-4095)

Noise is the baseline fluctuations that are irrelevant to the analysis. This Parameter allows you to select the quantity of noise that will be rejected by the SCENTOGRAPH. Recommended value is from 100 to 300.

1-5. Print Peak (0-4)

Use of this function requires a printer to be attached to the SCENTOGRAPH during operation. Enter 0 to disable printing. Enter 1 to print peak information for peaks exceeding Alarm 1 setting. Enter 2 to print peak data for peaks exceeding Alarm 2 value. Enter 3 to print both Alarm 1 and Alarm 2 peaks. Enter 4 to print data on all peaks. The peak data is printed as the peaks occur in the trace.

2. DUMB TERMINAL

This is an instrument testing option, only, and NOT applicable to user operation of the SCENTOGRAPH. The dumb terminal function is available to assist in phone service of the SCENTOGRAPH.

3. SHOW TEMPERATURE

To display the current Oven Temperature, press **'3'**and then **<ENTER>**. The upper number displayed is the current analog/digital conversion value, while the lower number is the current oven temperature in degrees centigrade.

4. RESET ALARM

Press '**4**' followed by <**ENTER**> to reset an alarm after activation.

5. BACKUP TRACES TO HARD DRIVE

Press '**5**' followed by <**ENTER**> to initiate backup of data to the "C" hard drive. This function must be used with great care. If the SCENTOGRAPH is not equipped with a computer containing a hard drive, the data will be erased from the current data disk and not saved if this function is implemented. For SCENTOGRAPH's equipped with a hard drive, the backup function is designed for users who normally save their data to the "A:" drive. This will copy the data from the "A:" disk, append it to the data on the "C:" hard disk and then erase the data on the "A:" disk. This permits the "A:" disk to be reused for additional data collection.

NOTE: IF THE BACKUP FUNCTION IS IMPLEMENTED WITH THE DATA DRIVE SELECTED AS "C" IN THE UTILITY MENU, ALL TRACE INFORMATION ON THE HARD DRIVE WILL BE ERASED. IF THE BACKUP FUNCTION IS IMPLEMENTED ON A PC WITHOUT A HARD DRIVE, ALL TRACE DATA ON THE DATA DISK WILL BE ERASED.

9. QUIT TO DOS

This closes all of the SCENTOGRAPH files, turns the SCENTOGRAPH off and returns control of the PC to DOS.

F. FUNCTIONAL DESCRIPTION OF SCENTOGRAPH OPERATION

The following is a description of the functions which occur during the operation of an analysis or calibration cycle. The PC monitor will display each operation as it is performed as follows:

WARMING UP

The program checks the current oven temperature and the amount of time that has passed since the SCENTOGRAPH was initiated. The SCENTOGRAPH has a built in delay which requires a five minute period to pass before allowing the instrument to operate an analysis cycle. This cycle will only occur when the first analysis is requested upon initiation of the SCENTOGRAPH, or when the oven temperature value is changed in the Operating Parameters.

PRE-PURGE

This function is only initiated when the Operating Parameter for External Purge is activated. This will permit an initial pre-purge of the head-space in the Purge and Trap module prior to sampling. Activation of the Pre-Purge will not effect the operation of the SCENTOGRAPH if the Purge and Trap accessory is not attached.

SAMPLING

The sample pump is automatically activated and the corresponding sample valves open. The sample pump will draw a sample into the SCENTOGRAPH for the time period indicated by the Sample Time parameter. If the instrument is in Calibration mode, a sample will be drawn from the internal calibration cylinder or from external calibration source. If the instrument is operating in the Analysis mode, a sample will be drawn from the Analyze port. Automatically, the monitor will identify the mode of operation, date and the time.

DELAY

The preconcentrator is purged to the atmosphere to remove humidity and excess gas from the absorbent tube. The purge will last for the pre-selected time.

FILAMENT

The heating filament is activated to thermally desorb the sample collected in the preconcentrator into the carrier gas stream as it enters the column.

INHIBIT

Upon injection, the sample is processed through the column with the SCENTOGRAPH ignoring undesired injection peaks during the period of time chosen for Inhibit Time. After the INHIBIT function has concluded, the trace is drawn on the screen in either Calibration or Sample analysis mode.

CALIBRATION

During Calibration, the electronic signal from the detector is sampled and averaged every 1/2 (0.5) second. Each new average is compared to the prior average to determine the movement of the electronic signal. Five consecutive increases in signal values determine the beginning of a peak and area counting is started. Fast noise peaks are, therefore, discriminated. The time corresponding to the maximum height of the peak is registered as the retention time. The end of the peak is determined by the signal returning to baseline or by the beginning of a new peak. All peak areas and retention times are stored on the data disk and displayed on the PC monitor. The entire chromatogram is displayed on the monitor as shown on Figure 10.

ANALYSIS

During Analysis, the same sequence previously described is performed. Peaks with Retention Times identical to those recorded during Calibration (plus or minus the percentage chosen under Analysis Peak Retention Time Tolerance Pct.) will be registered by their name and their actual concentration value. Other peaks will be registered as "UNKNOWN", their Retention Time will be displayed and their concentration calculated relative to the first calibration peak will be displayed. Areas of unidentified peaks are also stored. The analysis chromatogram is displayed on the monitor on top of the calibration chromatograph as shown on Figure 11. During Analysis or Calibration, either can be stopped by pressing the 'Esc' key. The message "*** ABORTED ***" followed by "Press Any Key To Continue" will appear on the display. Press the <**ENTER**> key to return to main operating menu.

G. THEORY OF CALIBRATION

Gas chromatography is considered to be one of the most effective analytical techniques for analyzing gases and vapors. Its unique capabilities are:

1. <u>High Resolution</u>

The ability to separate a mixture composed of many different chemicals into the individual components allowing identification and quantification.

2. <u>Identification</u>

If precise temperature control is used, separated chemicals can be identified with high accuracy.

3. <u>Quantification</u>

Since the response of various detectors used in gas chromatography is proportional to the concentration levels of the chemicals detected, concentration levels of the chemicals can be measured. However, NONE of the important features can be achieved without proper calibration. This section will deal with various methods of calibrations and those available for the SCENTOGRAPH.

I. CALIBRATION METHODS FOR IDENTIFICATION PURPOSES

Identification in gas chromatography is based on the principle that at constant temperature and carrier gas flow conditions, the retention time of each vapor (the travel time from the time of injection to the time of detection) is constant. In order to identify certain vapors, a sample of a given vapor must be injected into the column and its retention time measured. When an unknown sample is introduced to the column and its retention time is measured, and if found to match the previous sample, the unknown sample is identified as the same chemical as previously injected. If, for example, Benzene is to be analyzed, a sample of Benzene is injected into the column and its retention time is measured. A sample of air can then be analyzed for the presence of Benzene by the injection of a sample of air to the column and the measurement of the retention time (times) generated. If one retention time matches with that of Benzene, it can be concluded that the sample of air contained Benzene. This is true, however, only if the two injections were carried out under the same conditions. This procedure can be repeated for a number of chemicals, in the same manner.

Some factors should be considered when using this technique are:

A. Since Retention Times depend on temperature and gas flow, the gas chromographic system must maintain constant gas flow through the column and the column must be <u>accurately</u> and <u>evenly</u> thermally controlled.

B. Retention Time may vary slightly throughout the operation of the instrument, from day to day, and certainly for different columns (even of the same type). It is, therefore, essential to recalibrate (introduce new standards) before the start of analysis and, occasionally, during operation. Two methods are available for calibration for identification purposes.

I-1. DIRECT CALIBRATION

In the DIRECT CALIBRATION method, a standard for each vapor to be detected is introduced to the column for retention time measurement. For example, if vinyl chloride, methylene chloride, benzene and trichloroethylene are to be detected, a gas mixture containing certified concentration levels of these four gases should be introduced to the column. The Retention Time for each one of the chemicals is established. When a sample to be analyzed is introduced to the column and "produces" several Retention Times, the Retention Times which match with the four Retention Times produced in the calibration cycle indicate the presence of one or more of those compounds in the analysis sample.

This method is the most accurate and acceptable method in gas chromatography. It simply states that in order to identify a certain compound, the gas chromatograph should be calibrated with the same compound prior to the analysis. The SCENTOGRAPH has the capability of processing a mixture of up to 16 compounds for direct calibration purposes. During calibration, the instrument will record all Retention Times and assign a compound name to each Retention Time. During analysis, the instrument will match the Retention Times obtained with those recorded during calibration and identify those compounds which match. The SCENTOGRAPH, also, contains the ability to adjust the Retention Time Window, that is the range in which a Retention Time match will occur and a compound will be identified. Please see the discussion under **ANALYSIS PEAK RETENTION TIME TOLERANCE PERCENT.**

II. CALIBRATION METHODS FOR QUANTIFICATION PURPOSES

There are two methods of quantification in gas chromatography both based on the assumption that area under a peak represents the concentration of the chemical and is proportional to the chemical's concentration. The quantification methods are:

A. MULTIPOINT CALIBRATION METHOD

This method, which is the most accurate, is applied as follows:

Different concentration levels of a chemical are introduced to the gas chromatograph and a curve which indicates the peak areas (horizontal axis) vs. the concentration level (vertical axis) is plotted. When an unknown concentration of the same chemical is injected into the system, the area obtained is placed on the curve to derive its concentration level. This method is very accurate and can cover a large range of concentration. For example, if accurate range of both PPB levels and PPM levels are required to be detected, a curve consisting of the following concentrations:

1, 5, 10, 10, 50, 100, 200, 500 PPB

AND

1, 5, 10, 20, 50, PPM.

vs. their corresponding area derived from their analysis is drawn. This will assure that quantification at those levels is accurate as possible. However, this method is very cumbersome, time consuming, and applicable to one chemical at a time. Therefore, it is only used when a specific requirement exists.

B. TWO POINT CALIBRATION METHOD

This method, is sufficiently accurate for most applications and is the most commonly used in gas chromatography. Its accuracy, within a certain concentration level is satisfactory, while its operation is relatively easy. A calibration curve, similar to the previous one, is drawn, using two points only. One is zero with an assumed area count of zero and the other point consists of the area count obtained when a known concentration of the standard is injected, vs. its concentration level. If concentration levels between 0 and, for example, 2 PPM are required to be detected, a standard of 1 PPM is recommended to be used, and a curve consisting of 2 points, 0/0 and area for 1 PPM be established. Low PPB levels (1-50) and high PPM levels (10-50) may be detected in this method (using 1 PPM standard) with less accuracy, but the method is sufficiently accurate for .1 PPM to 5 PPM range of concentration. The method, therefore, is relatively simple and requires <u>one</u> concentration for calibration. Also, several chemicals can be calibrated at one time.

H. ANALYSIS METHODS

I. DIRECT ANALYSIS FOR IDENTIFICATION AND QUANTIFICATION USING REAL TIME CALIBRATION OF CHEMICAL STANDARDS CERTIFIED TO A CONSTANT CONCENTRATION LEVEL.

This method is based on direct calibration with up to 16 certified chemicals prior to analysis. During calibration, the SCENTOGRAPH stores the Retention times of all compounds, measures the area under their peaks, and assigns names and concentration values to each peak. During analysis, the instrument matches the retention times obtained with those of the calibration run. The retention time window can be set in the SCENTOGRAPH from zero percent indicating a perfect match must occur for identification, to 9% indicating a compound will be identified if its Retention Time matches that of the calibrant within +/- 9%. When there is a match, the name of the compound and the calculated concentration level is displayed on the monitor. Peaks with no match are identified as "unknown". This method is the most accurate and is identical to a laboratory gas chromatographic analysis.

II. DIRECT ANALYSIS WITH CALIBRATIONS STORED ON DATA DISKS.

This method is similar to the previous one with the exception that the calibrations with which the analysis data is compared is recalled from the SCENTOGRAPH's memory. Suppose at given parameters, a calibration established retention time values for various compounds. This calibration is now stored on the SCENTOGRAPH data disk. If an analysis is conducted at a later time, under the same parameters with different compounds as calibrants, and the instrument lists a peak as "unknown" during the analysis, it is possible to recall previous calibrations in order to match the "unknown" peak with prior calibrations. If there is a match, the SCENTOGRAPH will assign names and values to the unknown peaks and determine the concentration level.

III. COMPUTER COMPOUND LIBRARY SEARCH.

This method is based on the theory that "relative" Retention Times of compounds remain constant under different operating conditions. The SCENTOGRAPH accommodates up to 10 Compound Libraries, each containing up to 100 compound entries. Assuming that a library was established for 100 compounds using a specific column and operating conditions, the library would consist of one hundred names of compounds each with a value for the RRT (Relative Retention Time) assigned to it. Relative Retention Time is the actual retention time of compound measured under identical conditions. The retention times become "relative" when they are compared to a chromatogram which was run under slightly different operating conditions. The library retention times are adjusted to correspond to their calculated retention times under the new conditions, making them "relative" to the new chromatogram. A calibration is conducted with a number of calibrants up to 16, (for example Benzene, Toluene, and O-Xylene) all of which are included in the library. During the analysis, two "unknown" peaks are displayed. One peak is close to that of Benzene, and one peak is close to that of O-Xylene. To identify the unknowns, the retention times of the compounds in the library are first adjusted to the current operating conditions (making them Relative Retention Times). Any one of the Retention Times of the calibrants can be selected to update the library. If, for example, the Retention Time of Benzene in the present calibration run was found to be 150, assigning this value to the Benzene in the library will convert all RTs to Relative Retention Times. The library will now consist of one hundred compounds, each with a Relative Retention Time established for the particular condition to which the Benzene was calibrated. At this point, the SCENTOGRAPH will search the library data for Retention Times of compounds matching the two "unknowns" in the analysis, and if the retention time matches any in the library, the name of the compound will be displayed on the monitor and stored on the disk.

I. IDENTIFICATION OF UNKNOWN COMPOUNDS

Unknown compounds found in the analysis traces can be identified through several methods. The most accurate method of identification is through direct comparison with a known standard. The second method is identification by comparison of the analytical data with a pre-determined database of compounds and retention times. The third method is through comparison of the analytical trace with other previously run traces stored on the data disk.

I. DIRECT COMPARISON WITH CALIBRATION STANDARDS

For direct comparison of an unknown peak in an analysis trace, with a known standard, the operator must have some knowledge as to the possible compounds that might have been in the sample at the time the analysis was run. If compounds suspected of being in the sample can easily be identified and tested, they are analyzed by the SCENTOGRAPH and stored as individual traces. The resulting chromatograms of known compounds can be compared to the analysis chromatogram for identification of the unknown peak. The analysis of known compounds must be run using the operating conditions used during analysis of the sample containing the unknown, so the resulting chromatograms may be directly compared. This method, although time consuming and not always succesfull, is the most accurate means of identifing an unknown in the analysis trace.

II. LIBRARY DATA COMPARISON

Unknown compounds found in the analysis trace can be compared to stored data by using the CHROMATOGRAM REVIEW option and the FIT option in the SCENTOGRAPH operating program. See the section covering Computer Compound Library Search. Up to 100 compounds can be stored in a compound library for comparison by the FIT function.

III. COMPARISON OF DATA WITH PREVIOUS TRACES

The third method of identification is comparison of the sample chromatogram with previously generated chromatograms on the same data disk. For traces where the operating conditions are the same, any peak identified in one trace can be compared with an unknown peak in a second trace. If the retention times are similar, the unknwon peak can be identified by the known peak on the first trace. This can be done with the 'L' option and 'R' option of the CHROMATOGRAM REVIEW program as explained in the section covering the REIVEW program.

J. GENERAL OPERATING INSTRUCTIONS

The instrument can operate as a portable unit or at a fixed location, when attached to its battery chargers and connected to a fixed gas supply. The instrument battery charger should be connected to the SCENTOGRAPH whenever it is not in use.

RECOMMENDED: WHEN THE SCENTOGRAPH IS NOT IN USE, IT SHOULD BE CONNECTED TO THE BATTERY CHARGER. FOR CHARGING THE PC, PLEASE REFER TO THE PC MANUAL.

When the SCENTOGRAPH is used for portable operation, the battery chargers should be connected after each use. Prolonged high temperature operation will deplete battery power faster and recharging will be required earlier.

NOTE : AFTER EACH PORTABLE OPERATION, THE INSTRUMENT MUST BE CHARGED FOR AT LEAST 8 HOURS, PREFERABLY OVERNIGHT, BEFORE RESUMING OPERATION. FOR PORTABLE PROLONGED OPERATION OR HIGH TEMPERATURE OPERATION, A BATTERY PACK IS REQUIRED. FOR PROLONGED HIGH TEMPERATURE FIX LOCATION OPERATION, AN 8 AMP CHARGER IS REQUIRED.

<u>CARRIER GAS:</u> If the Scentograph includes a MICRO ARGON IONIZATION DETECTOR or an ARGON IONIZATION / ELECTRON CAPTURE DETECTOR, a high purity source of ARGON (99.995% or above) must be utilized. If the SCENTOGRAPH is equipped with a PHOTOIONIZATION or THERMAL CONDUCTIVITY DETECTOR, a high purity source of HELIUM (99.995% or better) must be used. The carrier gas <u>must</u> be Matheson High Purity Grade or equivalent.

NOTE : INDUSTRIAL GRADE CARRIER GAS WILL CAUSE CONTAMINATION AND INSTRUMENT MALFUNCTION.

CALIBRATION GAS: The SCENTOGRAPH contains an internal cylinder which may be filled with gaseous samples of the compounds under analysis mixed in a non-interfering medium. Up to sixteen (16) compounds will be identified by the SCENTOGRAPH during any one ANALYSIS or CALIBRATION. Valid and reliable gas chromatography requires each compound be certified to a pre-selected concentration level. Alternatively the SCENTOGRAPH can bypass the internal calibration cylinder and calibrate from an external source drawn through the CALIBRATION PORT located on the right side panel.

GAS CONNECTION: The SCENTOGRAPH is supplied with a quick connector to connect the internal carrier or calibration gas cylinders to an external gas supply. The connector is Swagelock Part No. OM-2-200. A 1/8" copper tube is supplied with the instrument and should be used to deliver gas to the instrument. When using an external source, a regulator or a gas cylinder adapter specifically designated for use with high purity gas must be used.

NOTE: GENERAL PURPOSE REGULATORS MAY CONTAMINATE THE GAS SUPPLY AND CAUSE INSTRUMENT MALFUNCTION.

I. PREPARING THE SCENTOGRAPH FOR OPERATION

STEP I: Verify that the batteries are fully charged by charging overnight, particularly if the SCENTOGRAPH is being used for the first time or after a prolonged period of non-use.

STEP II: Open the Carrier Gas Valve and the Calibration Gas Valve located on the Back Panel. Verify that both gas cylinders are full by inspecting the pressure gauges when valves are opened. Maximum pressure for each must be 1800 p.s.i. Pressure of 200 p.s.i. or lower indicates that the cylinders need to be refilled.

If CALIBRATION from an external sample is desired the Calibration Gas Valve should be turned off. The SCENTOGRAPH will automatically draw a sample through the Calibration Port located on its right side panel. If calibration from the Calibration Gas Cylinder is desired the Calibration Gas Valve should remain on.

STEP III: Inspect column pressure on the Column Pressure Gauge. The recommended range is between 10-30 p.s.i. Adjust column pressure if necessary. Use the allen key supplied in the start-up kit. Turning the adjustment screw on the Carrier Gas regulator clockwise will increase the column pressure while turning counterclockwise will decrease column pressure. Normal operating pressure should be 26 p.s.i.

STEP IV: Turn the SCENTOGRAPH on by lifting its cover and turning the power switch of the P.C. to the "ON" position. The PC will automatically power the SCENTOGRAPH. The title screen will be displayed on the PC monitor. The title will be held on will be displayed on the PC monitor. The title will be held on the PC monitor while the PARAMETERS, which were last in use at POWER OFF, are being loaded to the SCENTOGRAPH system. After the PARAMETERS are loaded, the OPERATION MENU will be displayed on the monitor.

STEP V: If new PARAMETERS are required press '**1**' followed by <**Enter**> and the OPERATION PARAMETERS will be displayed. To alter any PARAMETERS, press its number followed by <Enter>, and type in the new data as follows:

NOTE: ADDITIONAL INFORMATION ON EACH PARAMETER IS FOUND IN DESCRIPTION OF OPERATION

PRESS 1 to name the calibration mixture.

PRESS 2 to select sampling time. An increase in sampling time will increase instrument sensitivity. For syringe injection enter 0 for sampling time.

PRESS 3 to select delay time. If the SCENTOGRAPH is equipped with preconcentrator, delay time should remain at 0.5 seconds. Otherwise, delay time should be zero. Purge and Trap operation requires a 2.0 second delay. Injections require a 0 second delay.

PRESS 4 to select desorbtion time. If the SCENTOGRAPH is equipped with a Preconcentrator, desorbtion time should be set at 4 seconds. If not, desorbtion time should be set to zero.

PRESS 5 to select inhibit time used to eliminate undesired injection peaks. An inhibit time of 30 seconds is recommended for most compounds.

PRESS 6 to introduce the desired oven temperature.

PRESS 7 to select chart duration.

PRESS 8 to select the recalibration rate, for automatic operation only. This is the number of analysis cycles that will occur before recalibration takes place. This value will not affect manual operation.

PRESS 9 to select the time desired in minutes between analysis cycles, if automatic operation is desired. For manual operation enter zero (0).

PRESS 10 if your instrument is equipped with the backflush option. Enter one (1) to activate this option.

PRESS 11 to identify on the Chromatogram the type of the detector to be used. This is for information only and will not affect operation.

PRESS 12 to identify on the Chromatogram the gas chromatographic column to be used.

PRESS 13 to select the number of compounds to be processed, a maximum of 16.

PRESS 14 and for each compound identify:

- Peak Number (1-16)
- Substance Range (PPM/PPB)
- Calibration Concentration (.01-999999)
- Peak Alarm 1 Value
- Peak Alarm 2 Value

PRESS 15 to continue to Secondary Screen.

PRESS 17 to select final temperature if temperature programming is to be used. ENTER THE SAME VALUE AS ENTERED ON OVEN TEMPERATURE (#6) IF CONSTANT TEMPERATURE IS DESIRED.

PRESS 18 to select the time duration of temperature programming (do not exceed more than 4 degrees per minute).

PRESS 19 to choose the magnification desired for the chromatograph display.

PRESS 20 to choose the period of time during which Time Weighted Average will be calculated.

PRESS 21 to register the column pressure in P.S.I. (for information only).

PRESS 22 to enable the alarms at the preselected concentration levels.

PRESS 23 to enable operation of the external purge. The Purge Time is adjusted from 1 to 300 seconds. Enter 0 to disable.

PRESS 24 to name the compound data base.

PRESS 25 to enter compound data.

PRESS 99 to view the data base to be used for unknown peak identification.

When all entries have been completed, press <**ENTER**> to return to the OPERATION MENU.

PRESS 2, (ENTER) for AUTOMATIC OPERATION;
PRESS 3, (ENTER) for ANALYSIS RUN;
PRESS 4, (ENTER) for CALIBRATION RUN;
PRESS 5, (ENTER) for ANALYSIS SUMMARY;
PRESS 6, (ENTER) for CHROMATOGRAPH REVIEW;
PRESS 7, (ENTER) for PROGRAM UTILITY MENU;
PRESS 8, (ENTER) for ALARM RESET.

BE DISPLAYED. THE INSTRUMENT WILL OPERATE AS SOON AS TEMPERATURE REACHES THE RIGHT VALUE.

NOTE: IF ANALYSIS RUN (3) WAS INTRODUCED WITHOUT CALIBRATION, THE INSTRUMENT AUTOMATICALLY WILL PERFORM A CALIBRATION CYCLE BEFORE AN ANALYSIS CYCLE BEGINS.

STEP VIII: To turn the SCENTOGRAPH off, turn the PC ON/OFF switch to OFF. Turn both the Calibration Valve and the Carrier Gas Valve located on the Back Panel of the SCENTOGRAPH to the off position.

II. FIXED LOCATION OPERATION

STEP I: Connect the gas line from the external carrier gas source to the Carrier Gas Inlet located on the Back Panel of the instrument by sliding the knurled collar back and inserting the metal tip of the gas line into the collar. Release the collar when it firmly grips the metal tip. Turn on the external gas tank. (External gas pressure should not exceed 1800 PSI). The gas should be connected and left on for five (5) minutes before the SCENTOGRAPH is turned on. Adjust the column pressure if necessary.

STEP II. Connect the calibration gas to the Calibration Gas Inlet on the Back Panel of the instrument in the same manner. Gas pressure should not exceed 1800 PSI. If the Calibration Gas Cylinder is empty, an external calibration sample will be automatically drawn from the Calibration Port.

REMEMBER: THE CARRIER GAS SHOULD REMAIN OPEN AND CONNECTED TO

REMEMBER: THE CARRIER GAS SHOULD REMAIN OPEN AND CONNECTED TO THE INSTRUMENT FOR A MINIMUM OF 5 MINUTES BEFORE THE INSTRUMENT IS TURNED ON.

STEP III. Connect the battery chargers to the Charger Inputs located on the Back Panel of the SCENTOGRAPH.

REMEMBER: WHEN NOT IN USE, THE INSTRUMENT CHARGERS SHOULD REMAIN ATTACHED TO THE INSTRUMENT. SEE THE PC MANUAL FOR PROPER RECHARGING DIRECTIONS OF THE PC.

STEP IV. Proceed as previously described.

K. RECALL AND DISPLAY OF RESULTS

I. ANALYSIS SUMMARY

To recall SCENTOGRAPH results press '5' followed by <**ENTER**> in the OPERATION MENU. The ANALYSIS SUMMARY will be displayed. The ANALYSIS SUMMARY will detail for each Analysis the following information:

* Trace No. - Each Analysis or Calibration will automatically be assigned a number in the sequential order as it occurs.

* Date - Date Analysis occurred.

* Time - Time Analysis occurred.

* C/A - C indicates Calibration; A indicates Analysis

* Peak - Compound identified.

* Concnt.- Concentration level of compound identified.

* RT - Retention Time of compound identified.

* Area - This is the integrated area under the Peak.

* Name - The name assigned to the chromatogram.

There are various ways to access an ANALYSIS SUMMARY.

A. STARTING DATE:

To recall a series of Analysis, enter the date the Analysis series was initiated. All Analysis performed from the starting date to the end of the file will be displayed. If the date is unavailable or if you do not wish this form of recall, leave blank and PRESS (ENTER).

C. STARTING TRACE NO.:

Enter the number of the Trace you wish to begin the ANALYSIS SUMMARY. All Analysis starting with that trace number will be displayed. If the trace number is unavailable, or you do not wish this recall option, **PRESS** (ENTER).

D. TRACE NAME:

Enter the name of the Analysis. The summary will display only the Analysis which carries that name.

E. MULTIPLE INFORMATION:

Particular Analysis can be recalled by combining recall information. For example, recall the Analysis , (name) which occurred on and start with trace number " ".
(date)

II. CHROMATOGRAPH REVIEW:

PRESS **'6'** and then **<ENTER>** IN THE OPERATION MENU to recall chromatograms from the SCENTOGRAPH data disk. On the P.C. monitor, the message "ENTER TRACE NUMBER :" will appear. Entering the trace number will display the requested chromatogram (s).

If the trace number requested is a calibration, a single chromatogram will be displayed. If the trace number is an Analysis, the analysis chromatogram will be displayed on top of its calibration chromatogram.

III. CHROMATOGRAM MANIPULATION:

Once the chromatogram is recalled, there are various methods to manipulate the trace for analytical purposes press the <**SHIFT**> key and the '?' key simultaneously to access the HELP MENU. The HELP MENU has the following functions :

KEY

(+) ENTER + to INCREASE the gain of the display. The new gain value is displayed each time on the P.C. monitor.

(-) ENTER - to DECREASE the gain.

(<) (>) ENTER < or > to INCREASE/DECREASE horizontal display

(→) (←) ENTER → or ← to move the display by 30 seconds to the right or left.

(↑) (↓) ENTER ↑ or ↓ to move the display vertically.

All of these functions may enable you to focus on a particular analytical result. For example, the area in Figure 14 can be blown into Figure 15 by using the → key, the < key and the + key.

(T) TOGGLE PEAK INFORMATION TEXT DISPLAY.

PRESS 'T' to enter the peak information to the screen. Press 'T' again to remove the information.

(C) TOGGLE DISPLAY OF CALIBRATION TRACE.

Press 'C' to remove the calibration chromatogram from the P.C. monitor. Press 'C' to display it again.

(G) PRINT GRAPHIC SCREEN + PEAK INFORMATION.

When connected to a printer, the 'G' key will print all Peak information plus the chromatogram.

IV. DATABASE COMPARISON

Once a Database with Relative Retention Times has been established, the following manipulations can be performed:

(F) FIT ANALYZED PEAK TO DATABASE.

This function is intended for library search for identification of unknown compounds. (See Calibration Theory). Entering 'F' will display the information as illustrated on Figures 18-A, 18-B and 18-C. Enter the name of the calibration peak to which all Relative Retention Times will be computed. Once the calibration peak name has been entered the Retention Time of this compound will be transferred to the database and all the Retention Times of the other compounds in the database will be changed accordingly. The peak selected for the update should be the one whose Retention Time is the one closest to the unknown peak to be identified. Once the peak number is entered, Enter the number of the first unknown peak to be identified. If a match is found, it will be displayed on the P.C. monitor. To identify the next unknown peak, PRESS (ENTER). Peaks identified by this method will be registered with a + symbol to signify the method of identification.

(D) DISPLAY NAMES FOUND BY FIT FUNCTION Once the "FIT" is performed Press 'D' to display the names of the compounds found by this method.

V. CALIBRATION COMPARISON

To compare unknown peaks to previous calibrations or to perform a "fingerprint" comparison for multiple peak compounds use the following:

(L) LOAD AN ALTERNATE CALIBRATION TRACE

This parameter allows the replacement of the lower calibration trace with <u>any</u> other trace. There are two purposes for using this function:

A. FINGERPRINT IDENTIFICATION.

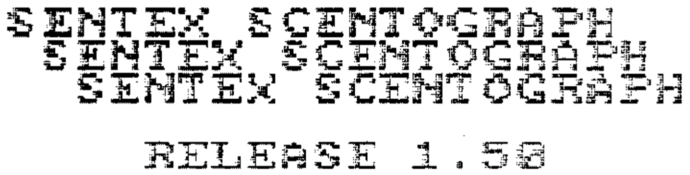
There are several samples which consist of multiple peaks (P.C.B.s) and the recognition of these samples are carried out not be single peak identification but, instead, by pattern recognition. Multiple peaks standards can be used as the calibration source for example, Arclor 1221. 1241, and 1248). After an analysis is performed, the different calibration traces can be brought to the P.C. display and compared to the analysis. In this manner, pattern recognition or FINGERPRINT IDENTIFICATION can be obtained. **PRESS** L (ENTER) to enter the trace number to be displayed under the current analysis. Different trace numbers can be entered until a FINGERPRINT IDENTIFICATION is obtained.

B. IDENTIFICATION OF UNKNOWN COMPOUNDS.

If unknown compounds are present in the analysis, a different calibration trace, which was performed before or <u>after</u> the analysis, under the same flow and temperature conditions can be introduced. **PRESS** L to introduce a different calibration trace. After an alternative calibration trace has been presented on the P.C. monitor, a simulated Analysis can occur as follows:

PRESS '**R**' and the P.C. will perform a simulated analysis as if this newly presented trace was the actual calibration. Any match between the unknown peaks and the new calibration trace will identify the compound and its concentration level. It will, however, distinguish this identification by adding * to the name of the compound. This mark will now remain in ANALYSIS SUMMARY and in the CHROMATOGRAM REVIEW whenever this chromatogram is recalled.

L. FIGURES

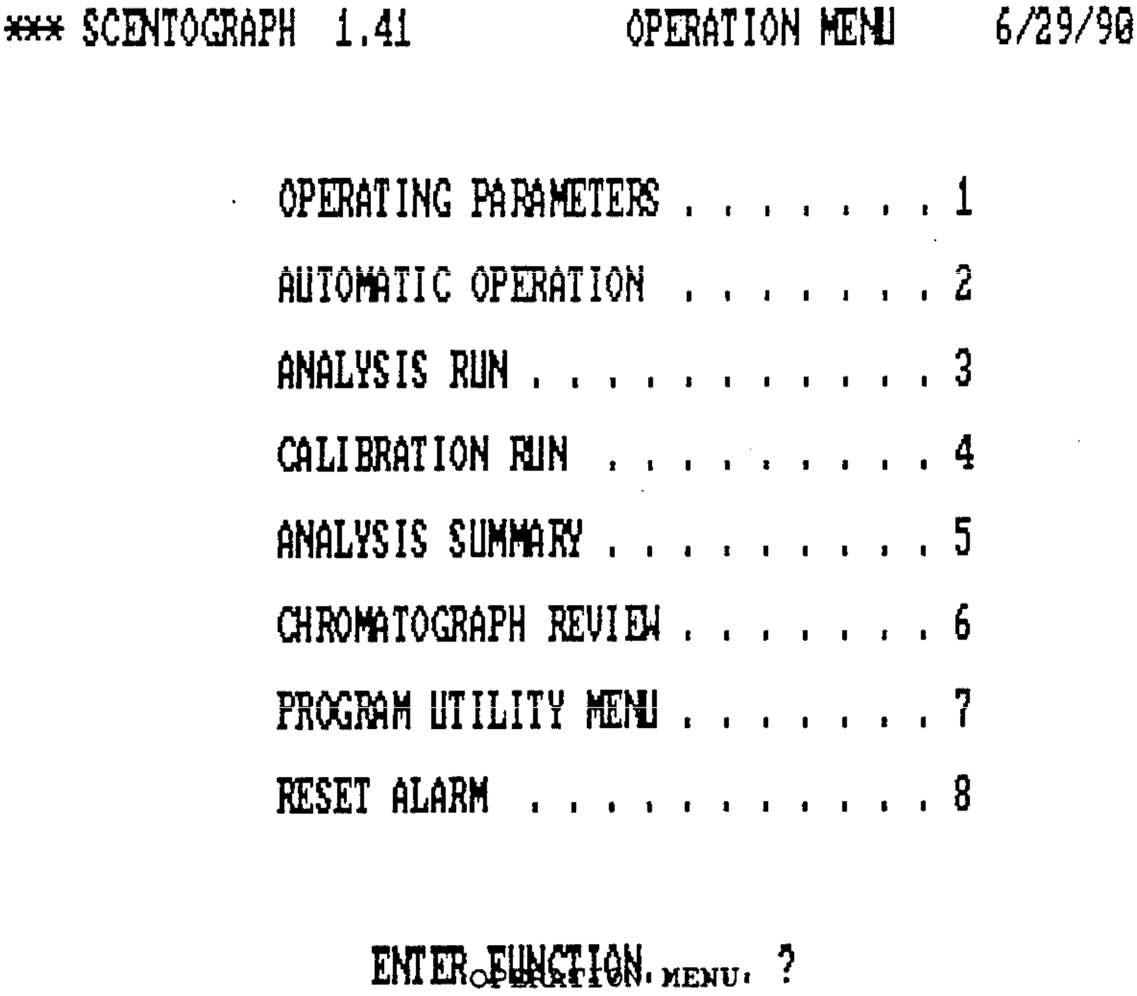


SENTEX SCENTOGRAPH
SENTEX SCENTOGRAPH
SENTEX SCENTOGRAPH

RELEASE 1.58

TITLE SCREEN

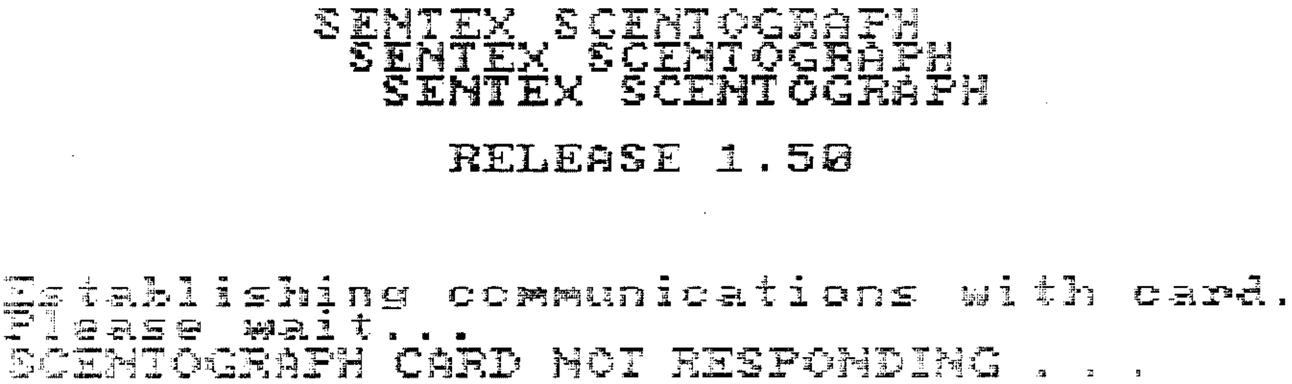
FIGURE 1.



```
*** SCENTOGRAPH  1.41          OPERATION MENU     6/29/90

          OPERATING PARAMETERS . . . . . . . . 1

          AUTOMATIC OPERATION  . . . . . . . . 2

          ANALYSIS RUN . . . . . . . . . . . . 3

          CALIBRATION RUN  . . . . . . . . . . 4

          ANALYSIS SUMMARY . . . . . . . . . . 5

          CHROMATOGRAPH REVIEW . . . . . . . . 6

          PROGRAM UTILITY MENU . . . . . . . . 7

          RESET ALARM  . . . . . . . . . . . . 8


               ENTER FUNCTION  ?
```

OPERATION MENU.

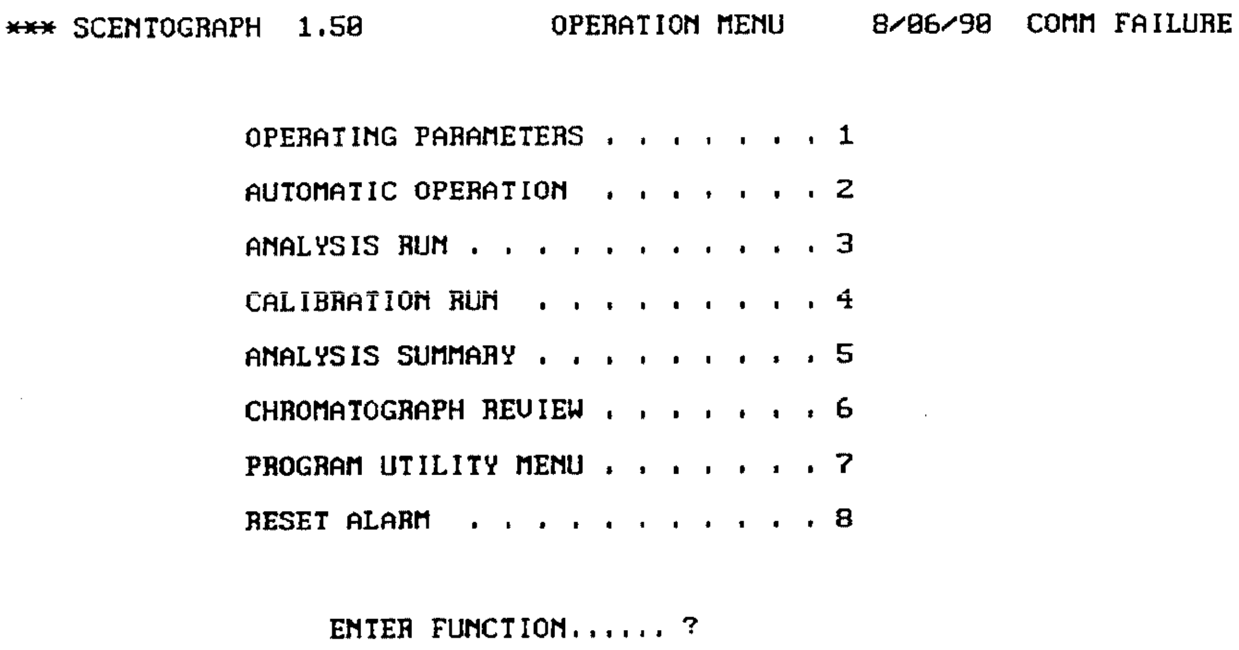
FIGURE 2.



```
SENTEX SCENTOGRAPH
 SENTEX SCENTOGRAPH
  SENTEX SCENTOGRAPH

      RELEASE 1.50


Establishing communications with card.
Please wait...
SCENTOGRAPH CARD NOT RESPONDING . . .
```

INDICATION OF COMMUNICATION FAILURE

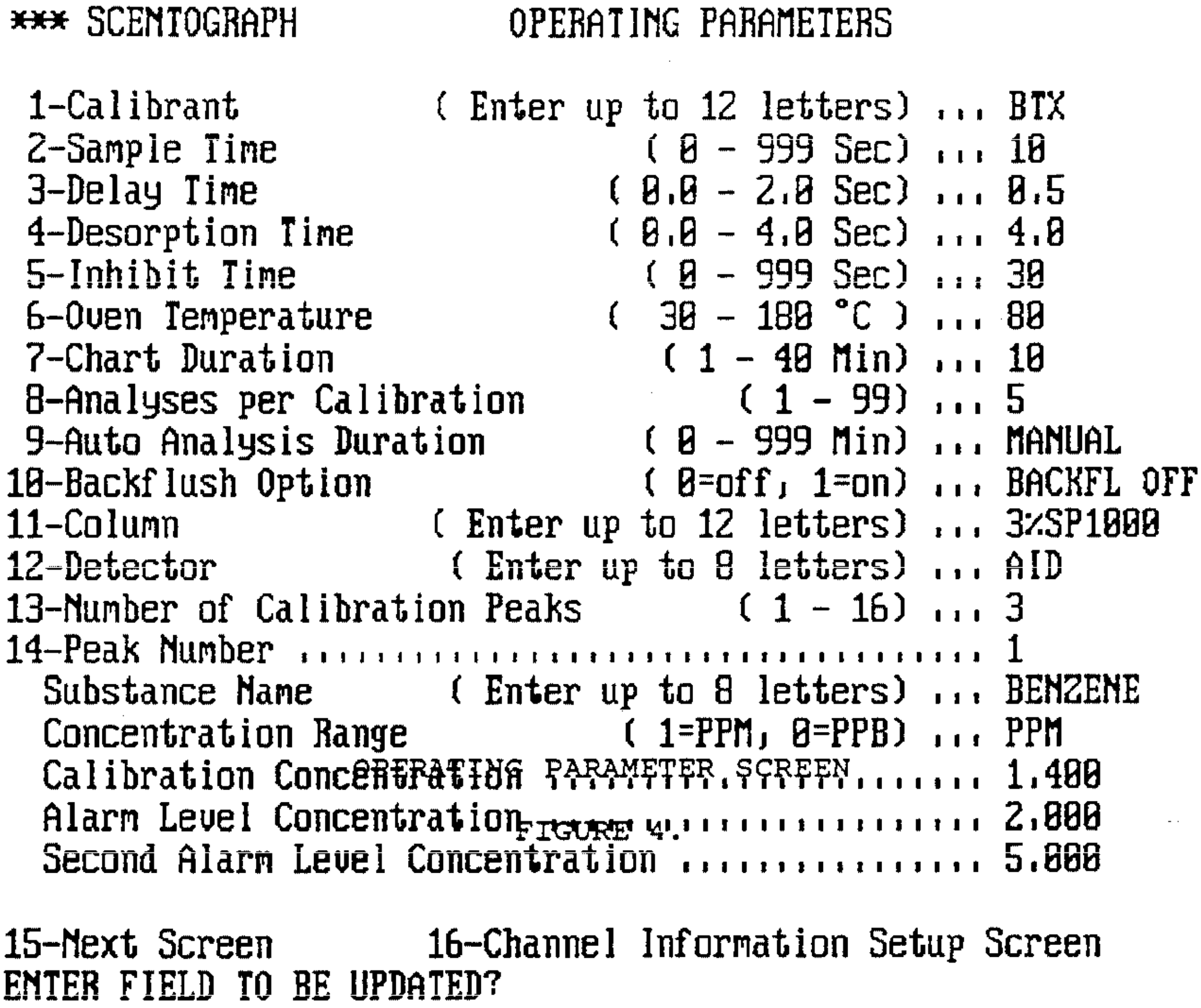
FIGURE 3A.



```
*** SCENTOGRAPH  1.50           OPERATION MENU     8/06/90  COMM FAILURE

              OPERATING PARAMETERS . . . . . . . . 1

              AUTOMATIC OPERATION  . . . . . . . . 2

              ANALYSIS RUN . . . . . . . . . . . . 3

              CALIBRATION RUN  . . . . . . . . . . 4

              ANALYSIS SUMMARY . . . . . . . . . . 5

              CHROMATOGRAPH REVIEW . . . . . . . . 6

              PROGRAM UTILITY MENU . . . . . . . . 7

              RESET ALARM  . . . . . . . . . . . . 8

                   ENTER FUNCTION...... ?
```

COMMUNICATION FAILURE MESSAGE ON OPERATION MENU

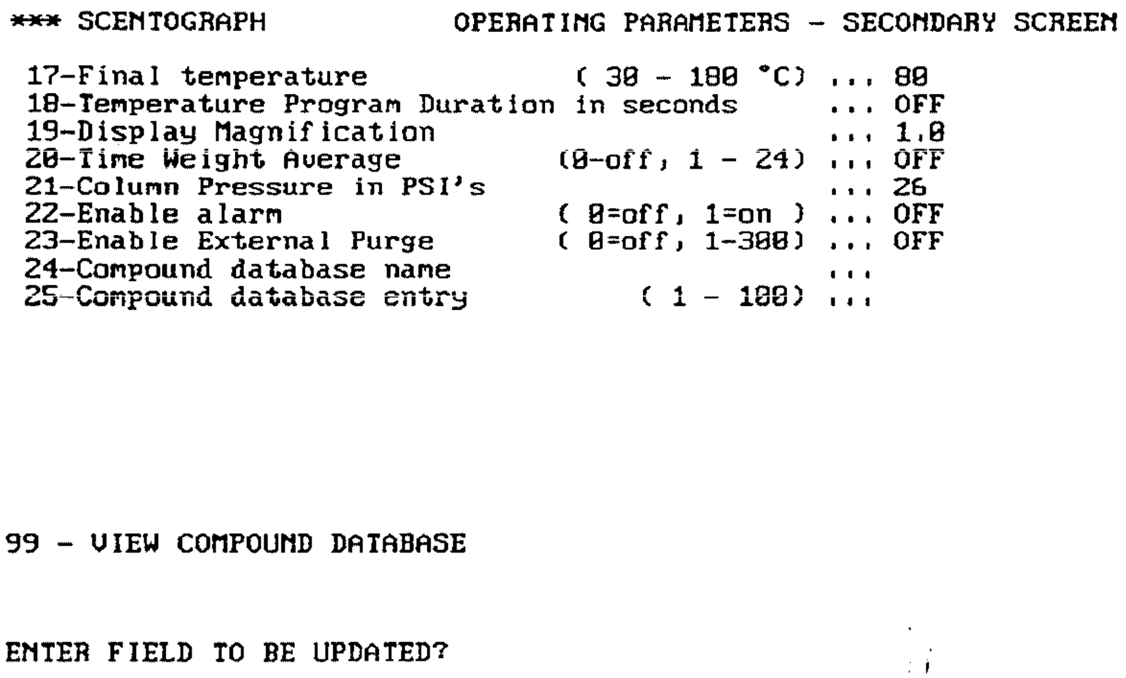
FIGURE 3B.



```
*** SCENTOGRAPH           OPERATING PARAMETERS

 1-Calibrant          ( Enter up to 12 letters) ... BTX
 2-Sample Time                ( 0 - 999 Sec) ... 10
 3-Delay Time               ( 0.0 - 2.0 Sec) ... 0.5
 4-Desorption Time          ( 0.0 - 4.0 Sec) ... 4.0
 5-Inhibit Time               ( 0 - 999 Sec) ... 30
 6-Oven Temperature         (  30 - 180 °C ) ... 80
 7-Chart Duration               ( 1 - 40 Min) ... 10
 8-Analyses per Calibration         ( 1 - 99) ... 5
 9-Auto Analysis Duration     ( 0 - 999 Min) ... MANUAL
10-Backflush Option           ( 0=off, 1=on) ... BACKFL OFF
11-Column             ( Enter up to 12 letters) ... 3%SP1000
12-Detector            ( Enter up to 8 letters) ... AID
13-Number of Calibration Peaks      ( 1 - 16) ... 3
14-Peak Number ...................................... 1
  Substance Name       ( Enter up to 8 letters) ... BENZENE
  Concentration Range         ( 1=PPM, 0=PPB) ... PPM
  Calibration Concentration ........................ 1.400
  Alarm Level Concentration ......................... 2.000
  Second Alarm Level Concentration .................. 5.000

15-Next Screen         16-Channel Information Setup Screen
ENTER FIELD TO BE UPDATED?
```

OPERATING PARAMETER SCREEN

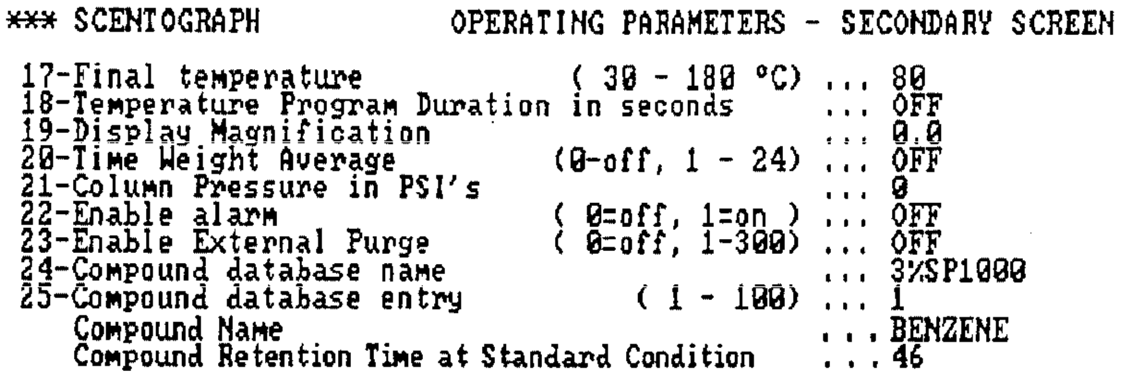
FIGURE 4.



```
*** SCENTOGRAPH          OPERATING PARAMETERS - SECONDARY SCREEN

 17-Final temperature              ( 30 - 100 °C) ... 80
 18-Temperature Program Duration in seconds      ... OFF
 19-Display Magnification                        ... 1.0
 20-Time Weight Average          (0-off, 1 - 24) ... OFF
 21-Column Pressure in PSI's                     ... 26
 22-Enable alarm                 ( 0=off, 1=on ) ... OFF
 23-Enable External Purge        ( 0=off, 1-300) ... OFF
 24-Compound database name                       ...
 25-Compound database entry           ( 1 - 100) ...




99 - VIEW COMPOUND DATABASE


ENTER FIELD TO BE UPDATED?
```

SECONDARY PARAMETERS SCREEN

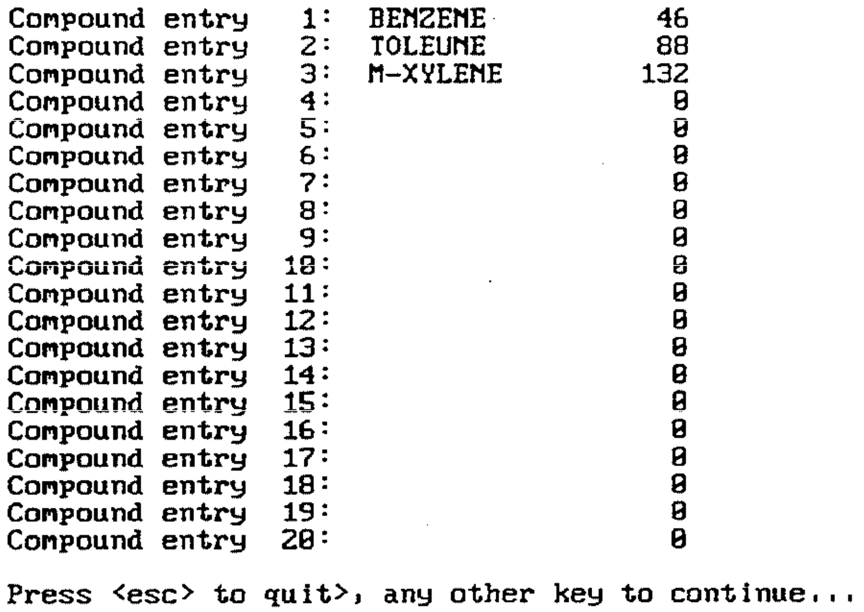
FIGURE 5.



```
*** SCENTOGRAPH          OPERATING PARAMETERS - SECONDARY SCREEN

 17-Final temperature              ( 30 - 180 °C) ... 80
 18-Temperature Program Duration in seconds     ... OFF
 19-Display Magnification                       ... 0.0
 20-Time Weight Average           (0-off, 1 - 24) ... OFF
 21-Column Pressure in PSI's                    ... 0
 22-Enable alarm                  ( 0=off, 1=on ) ... OFF
 23-Enable External Purge         ( 0=off, 1-300) ... OFF
 24-Compound database name                      ... 3%SP1000
 25-Compound database entry            ( 1 - 100) ... 1
    Compound Name                               ... BENZENE
    Compound Retention Time at Standard Condition   ... 46
```

COMPOUND DATABASE ENTRY

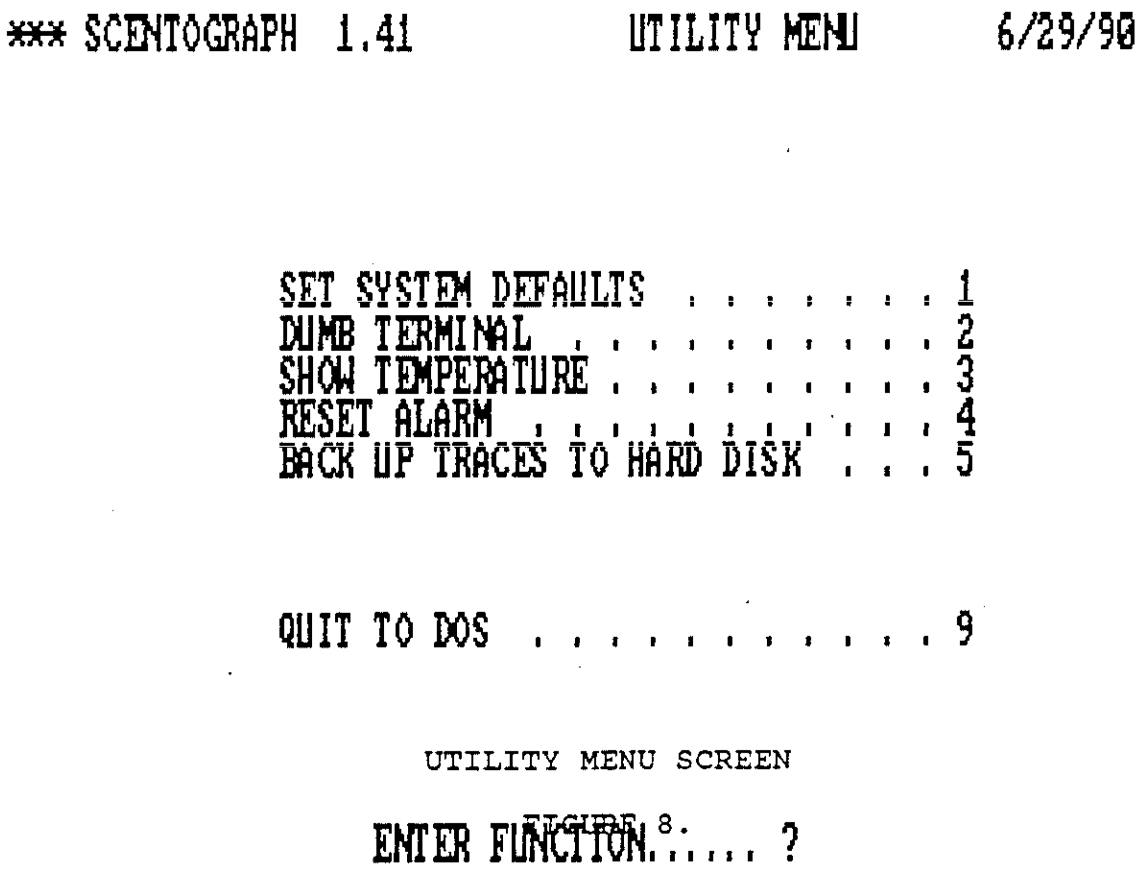
FIGURE 6.



```
Compound entry   1:  BENZENE          46
Compound entry   2:  TOLEUNE          88
Compound entry   3:  M-XYLENE        132
Compound entry   4:                    0
Compound entry   5:                    0
Compound entry   6:                    0
Compound entry   7:                    0
Compound entry   8:                    0
Compound entry   9:                    0
Compound entry  10:                    0
Compound entry  11:                    0
Compound entry  12:                    0
Compound entry  13:                    0
Compound entry  14:                    0
Compound entry  15:                    0
Compound entry  16:                    0
Compound entry  17:                    0
Compound entry  18:                    0
Compound entry  19:                    0
Compound entry  20:                    0

Press <esc> to quit>, any other key to continue...
```

VIEWING ENTRIES IN COMPOUND DATABASE

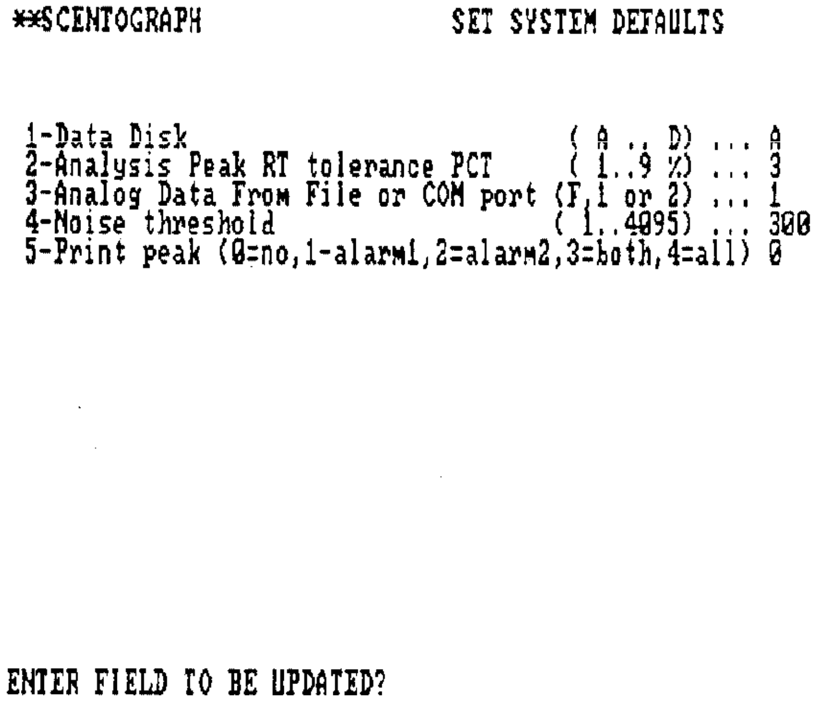
FIGURE 7.



```
*** SCENTOGRAPH  1.41          UTILITY MENU       6/29/90



            SET SYSTEM DEFAULTS  . . . . . . . 1
            DUMB TERMINAL  . . . . . . . . . . 2
            SHOW TEMPERATURE . . . . . . . . . 3
            RESET ALARM  . . . . . . . . . . . 4
            BACK UP TRACES TO HARD DISK  . . . 5


            QUIT TO DOS  . . . . . . . . . . . 9


                  ENTER FUNCTION...... ?
```

UTILITY MENU SCREEN

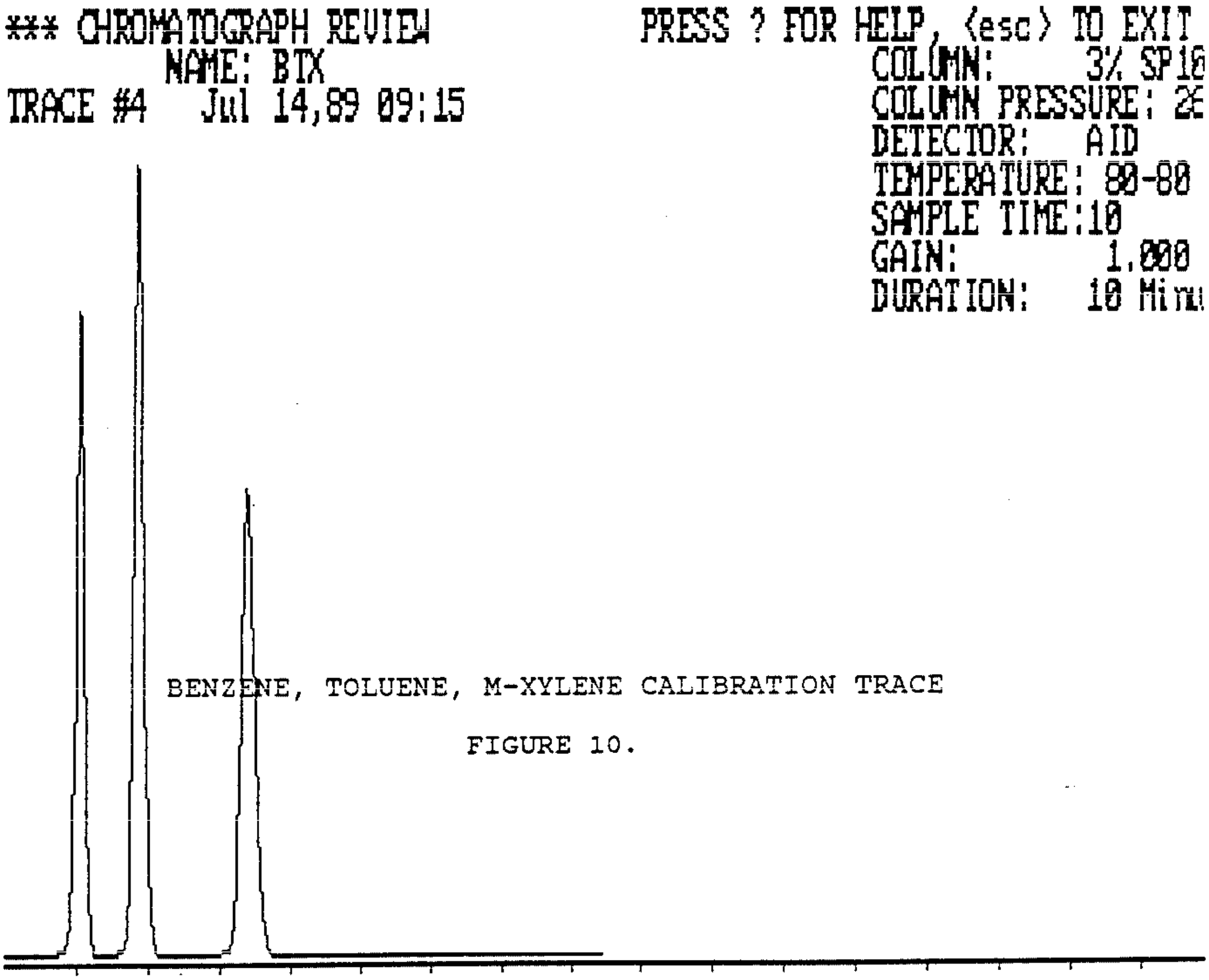
FIGURE 8.



```
**SCENTOGRAPH                SET SYSTEM DEFAULTS

 1-Data Disk                          ( A .. D) ... A
 2-Analysis Peak RT tolerance PCT     ( 1..9 %) ... 3
 3-Analog Data From File or COM port (F,1 or 2) ... 1
 4-Noise threshold                    ( 1..4095) ... 300
 5-Print peak (0=no,1-alarm1,2=alarm2,3=both,4=all) 0




ENTER FIELD TO BE UPDATED?
```

SYSTEM DEFAULTS ENTRY SCREEN

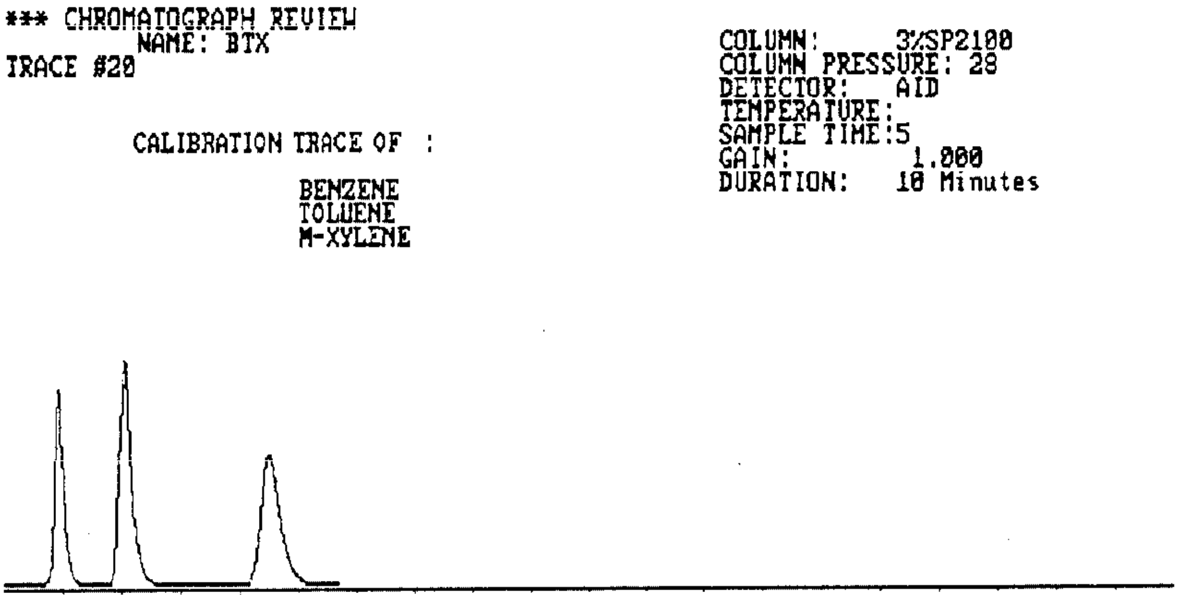
FIGURE 9.



```
*** CHROMATOGRAPH REVIEW              PRESS ? FOR HELP, <esc> TO EXIT
          NAME: BTX                                 COLUMN:     3% SP1
TRACE #4   Jul 14,89 09:15                          COLUMN PRESSURE: 2
                                                    DETECTOR:   AID
                                                    TEMPERATURE: 80-80
                                                    SAMPLE TIME:10
                                                    GAIN:        1.000
                                                    DURATION:   10 Min
```

BENZENE, TOLUENE, M-XYLENE CALIBRATION TRACE

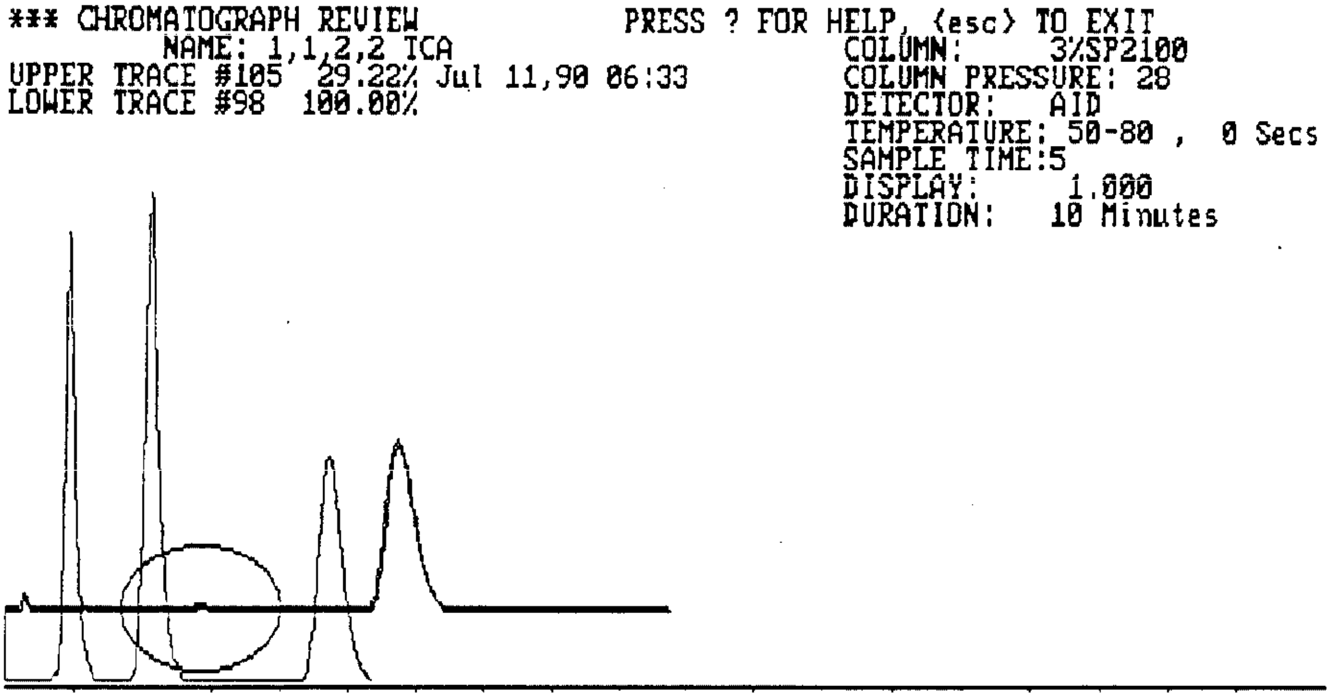
FIGURE 10.



```
*** CHROMATOGRAPH REVIEW
          NAME: BTX                        COLUMN:      3%SP2100
TRACE #20                                  COLUMN PRESSURE: 28
                                           DETECTOR:    AID
                                           TEMPERATURE:
         CALIBRATION TRACE OF  :           SAMPLE TIME:5
                                           GAIN:          1.000
                      BENZENE              DURATION:    10 Minutes
                      TOLUENE
                      M-XYLENE
```

ANALYSIS TRACE - VISUAL COMPARISON WITH CALIBRATION TRACE

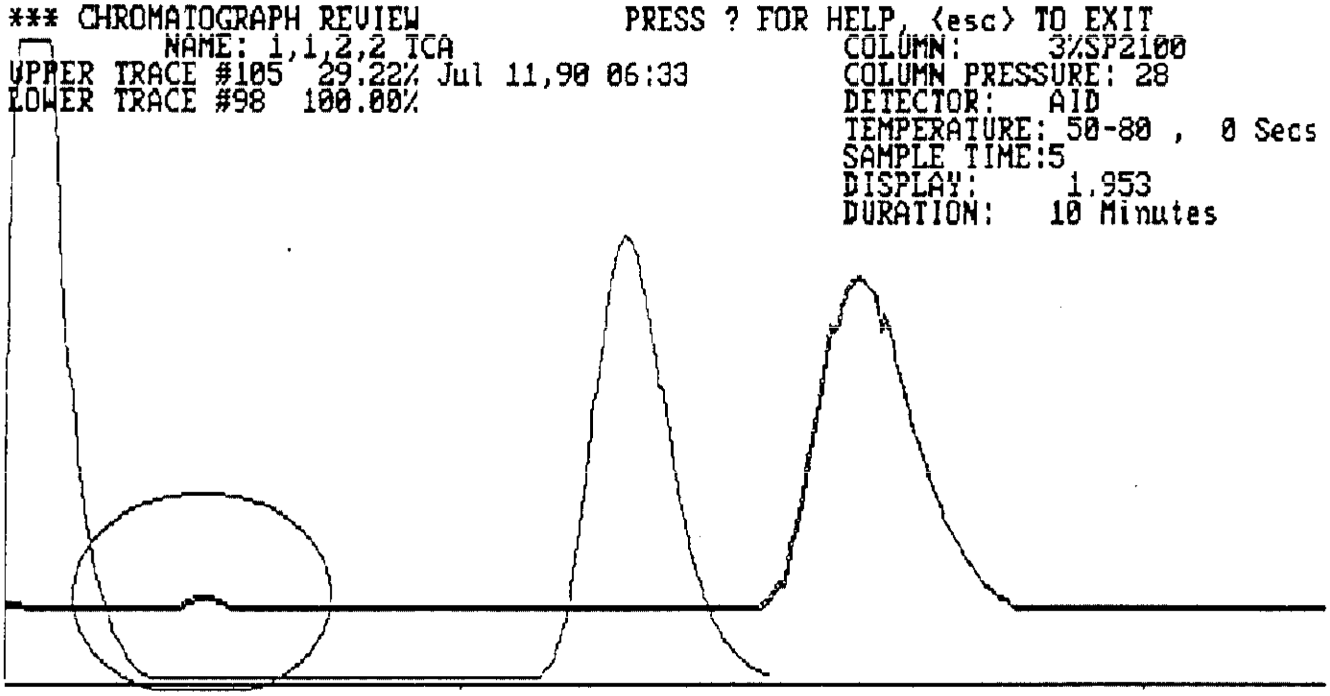
FIGURE 11.



```
*** CHROMATOGRAPH REVIEW            PRESS ? FOR HELP, (esc) TO EXIT
        NAME: 1,1,2,2 TCA                       COLUMN:     3%SP2100
UPPER TRACE #105  29.22% Jul 11,90 06:33        COLUMN PRESSURE: 28
LOWER TRACE #98  100.00%                        DETECTOR:   AID
                                                TEMPERATURE: 50-80 ,  0 Secs
                                                SAMPLE TIME:5
                                                DISPLAY:      1.000
                                                DURATION:   10 Minutes
```

AREA TO BE MAGNIFIED DURING CHROMATOGRAPH REVIEW

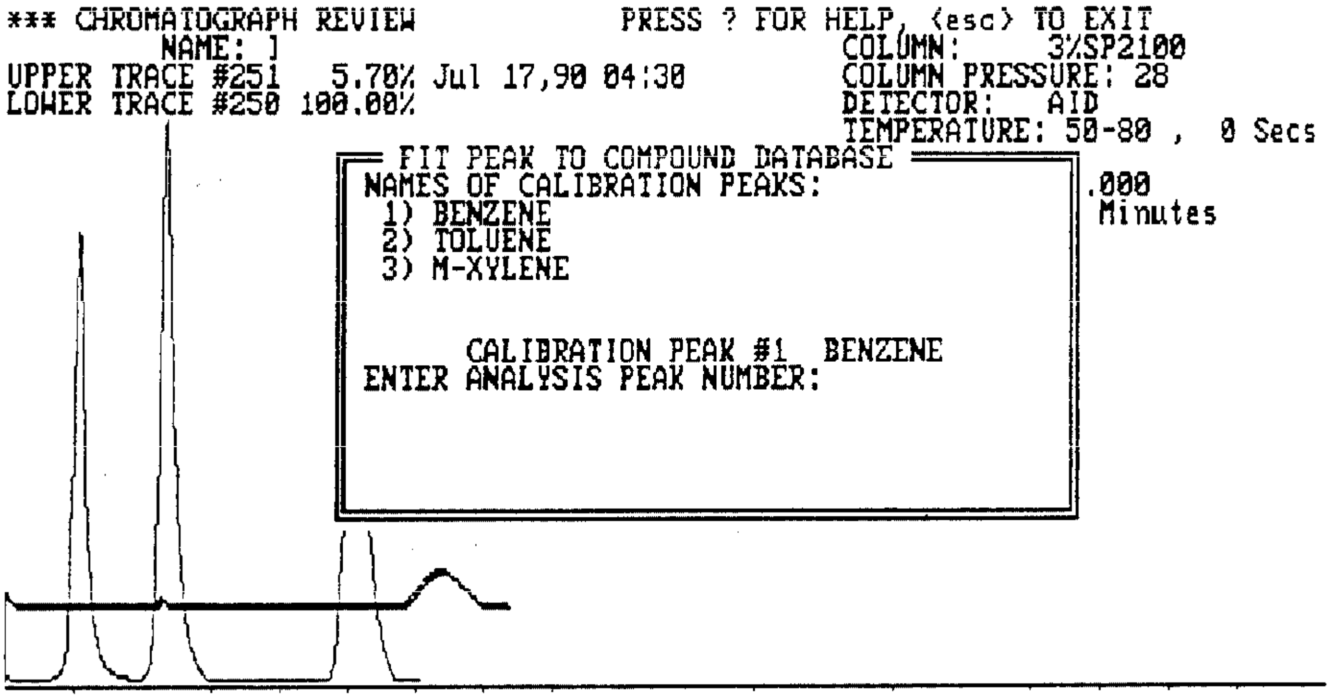
FIGURE 14.



```
*** CHROMATOGRAPH REVIEW              PRESS ? FOR HELP, <esc> TO EXIT
          NAME: 1,1,2,2 TCA                   COLUMN:     3%SP2100
UPPER TRACE #105  29.22% Jul 11,90 06:33      COLUMN PRESSURE: 28
LOWER TRACE #98  100.00%                      DETECTOR:   AID
                                              TEMPERATURE: 50-80 ,  0 Secs
                                              SAMPLE TIME:5
                                              DISPLAY:      1.953
                                              DURATION:   10 Minutes
```

MAGNIFIED AREA AFTER DISPLAY MANIPULATION

FIGURE 15.

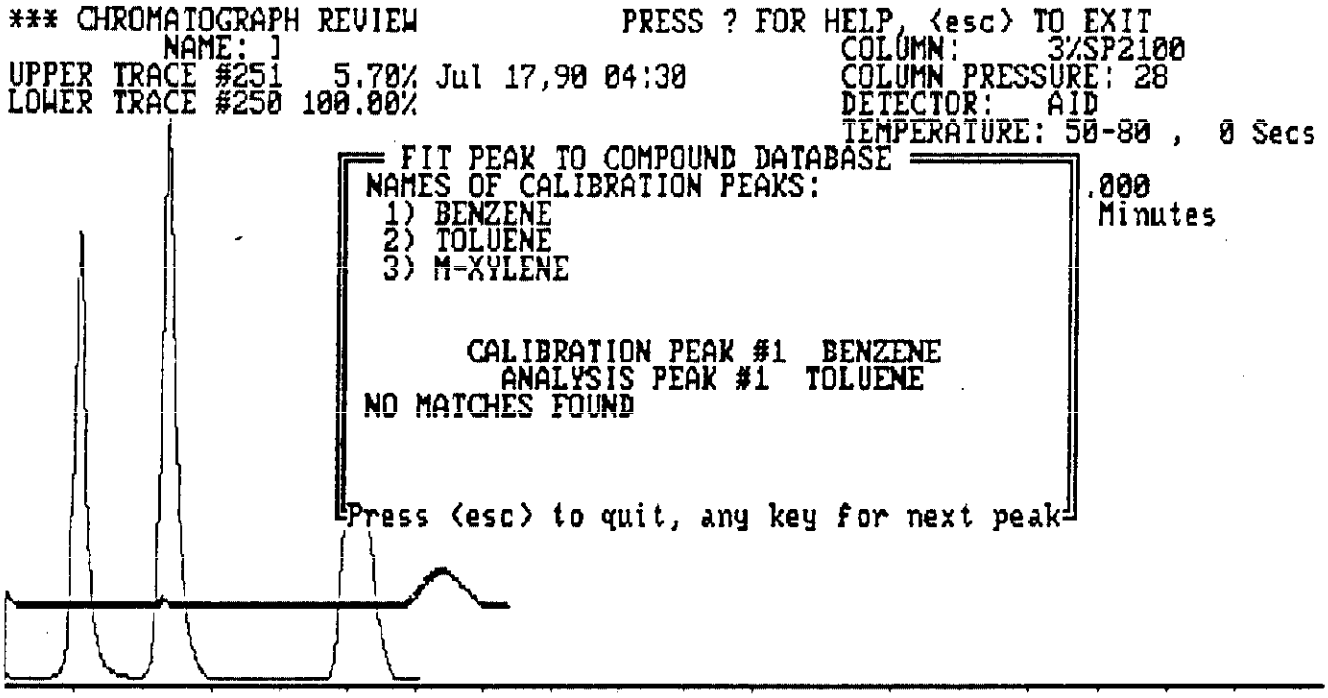


```
*** CHROMATOGRAPH REVIEW            PRESS ? FOR HELP, <esc> TO EXIT
          NAME: ]                              COLUMN:      3%SP2100
UPPER TRACE #251   5.70% Jul 17,90 04:30       COLUMN PRESSURE: 28
LOWER TRACE #250 100.00%                       DETECTOR:   AID
                                               TEMPERATURE: 50-80 ,  0 Secs
            FIT PEAK TO COMPOUND DATABASE
            NAMES OF CALIBRATION PEAKS:                  .000
             1) BENZENE                                   Minutes
             2) TOLUENE
             3) M-XYLENE

                  CALIBRATION PEAK #1  BENZENE
            ENTER ANALYSIS PEAK NUMBER:
```

INITIAL SCREEN WHEN USING FIT FUNCTION

ENTER CALIBRATION PEAK TO COMPARE LIBRARY DATA WITH

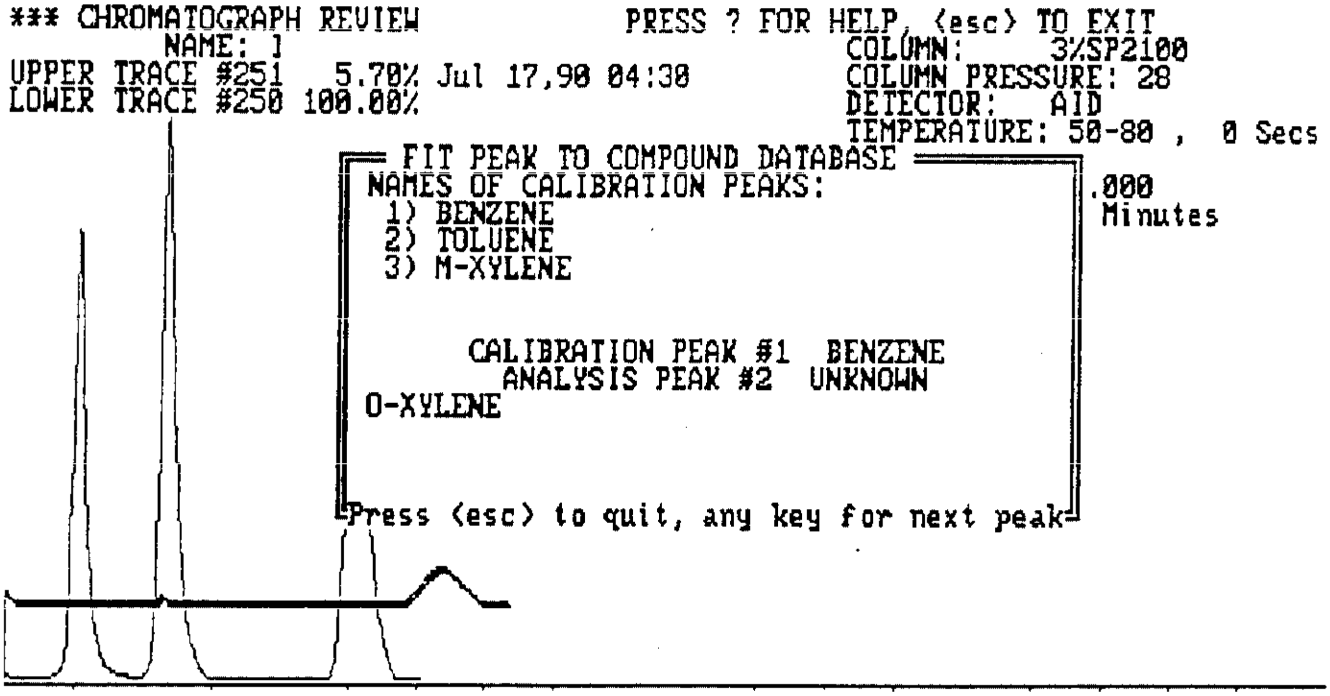
FIGURE 18-A.



```
*** CHROMATOGRAPH REVIEW            PRESS ? FOR HELP, <esc> TO EXIT
          NAME: ]                              COLUMN:     3%SP2100
UPPER TRACE #251   5.70% Jul 17,90 04:30       COLUMN PRESSURE: 28
LOWER TRACE #250 100.00%                       DETECTOR:   AID
                                               TEMPERATURE: 50-80 ,  0 Secs
             ═ FIT PEAK TO COMPOUND DATABASE ═
              NAMES OF CALIBRATION PEAKS:                        .000
               1) BENZENE                                        Minutes
               2) TOLUENE
               3) M-XYLENE


                  CALIBRATION PEAK #1  BENZENE
                    ANALYSIS PEAK #1  TOLUENE
              NO MATCHES FOUND



             Press <esc> to quit, any key for next peak
```

ENTER ANALYSIS PEAK TO COMPARE LIBRARY DATA WITH

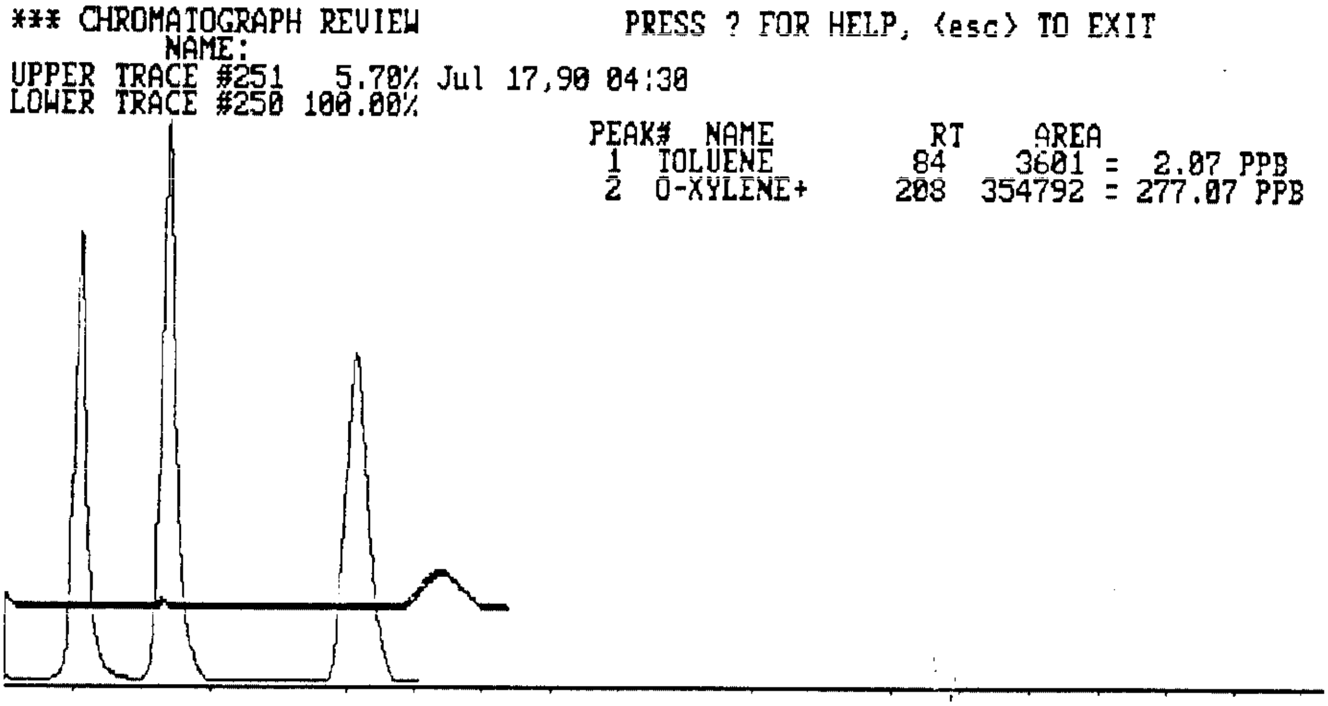
FIGURE 18.B



```
*** CHROMATOGRAPH REVIEW               PRESS ? FOR HELP, <esc> TO EXIT
          NAME: 1                                COLUMN:     3%SP2100
UPPER TRACE #251   5.70% Jul 17,90 04:30         COLUMN PRESSURE: 28
LOWER TRACE #250 100.00%                         DETECTOR:   AID
                                                 TEMPERATURE: 50-80 ,  0 Secs
                   FIT PEAK TO COMPOUND DATABASE
                   NAMES OF CALIBRATION PEAKS:                    .000
                    1) BENZENE                                    Minutes
                    2) TOLUENE
                    3) M-XYLENE


                        CALIBRATION PEAK #1  BENZENE
                          ANALYSIS PEAK #2  UNKNOWN
                   O-XYLENE



                   Press <esc> to quit, any key for next peak
```

FIT FUNCTION MATCHES UNKNOWN PEAK WITH LIBRARY DATA

FIGURE 18-C.

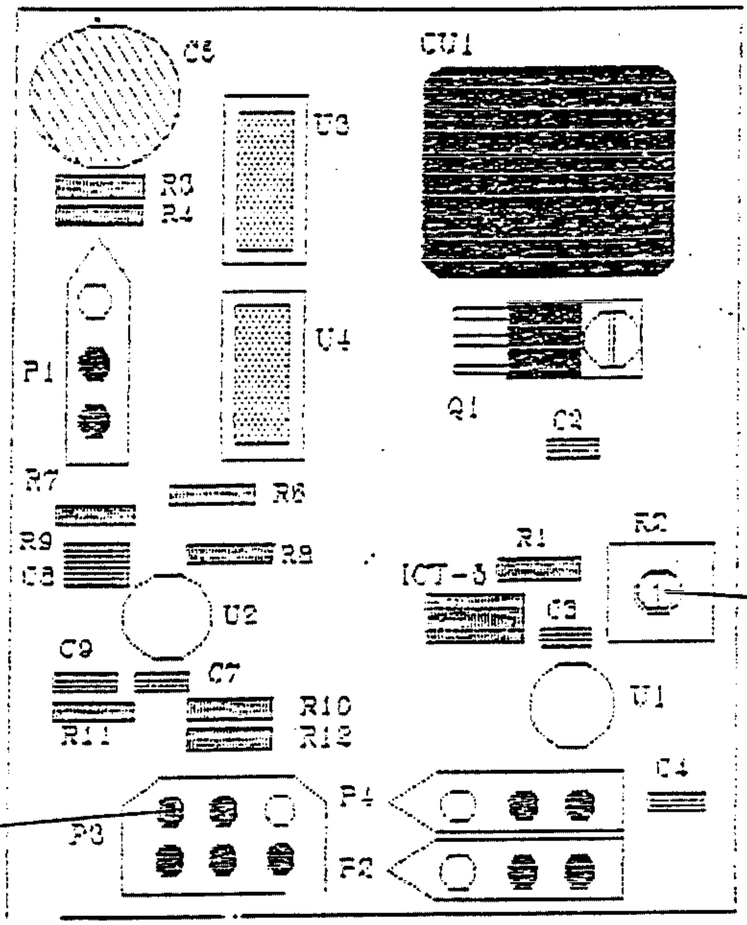


```
*** CHROMATOGRAPH REVIEW              PRESS ? FOR HELP, <esc> TO EXIT
            NAME:
UPPER TRACE #251   5.70% Jul 17,90 04:30
LOWER TRACE #250 100.00%
                                 PEAK#  NAME          RT    AREA
                                   1   TOLUENE        84     3601 =   2.07 PPB
                                   2   O-XYLENE+     208   354792 = 277.07 PPB
```

PEAK IDENTIFIED BY FIT FUNCTION IS LABELED WITH '+'

FIGURE 18-D.

SCENTOGRAPH
HIGH VOLTAGE BOARD



Electronic Gain adjustment
R2

nal Output
Electronic gain
he

FIGURE 19.

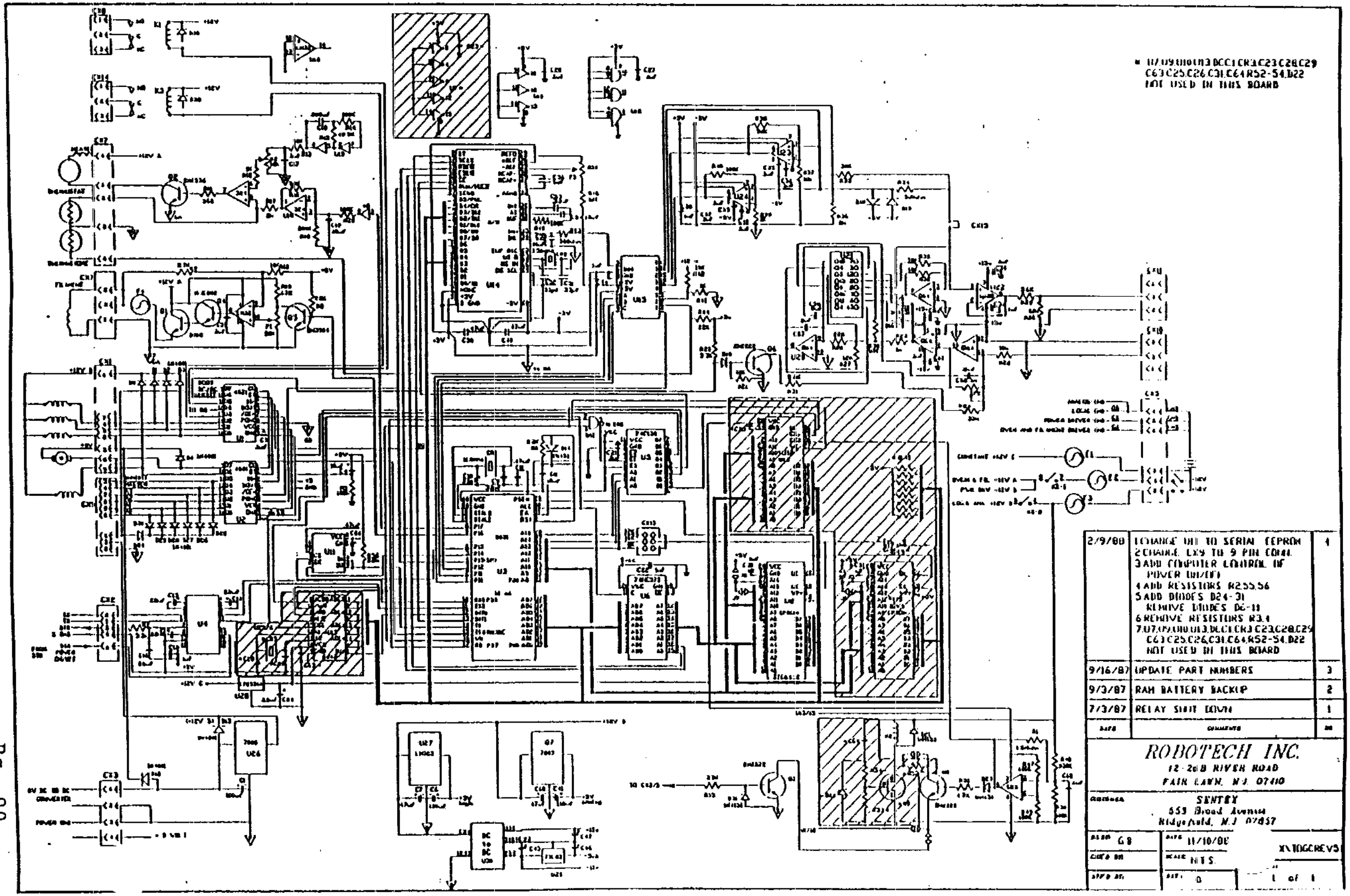
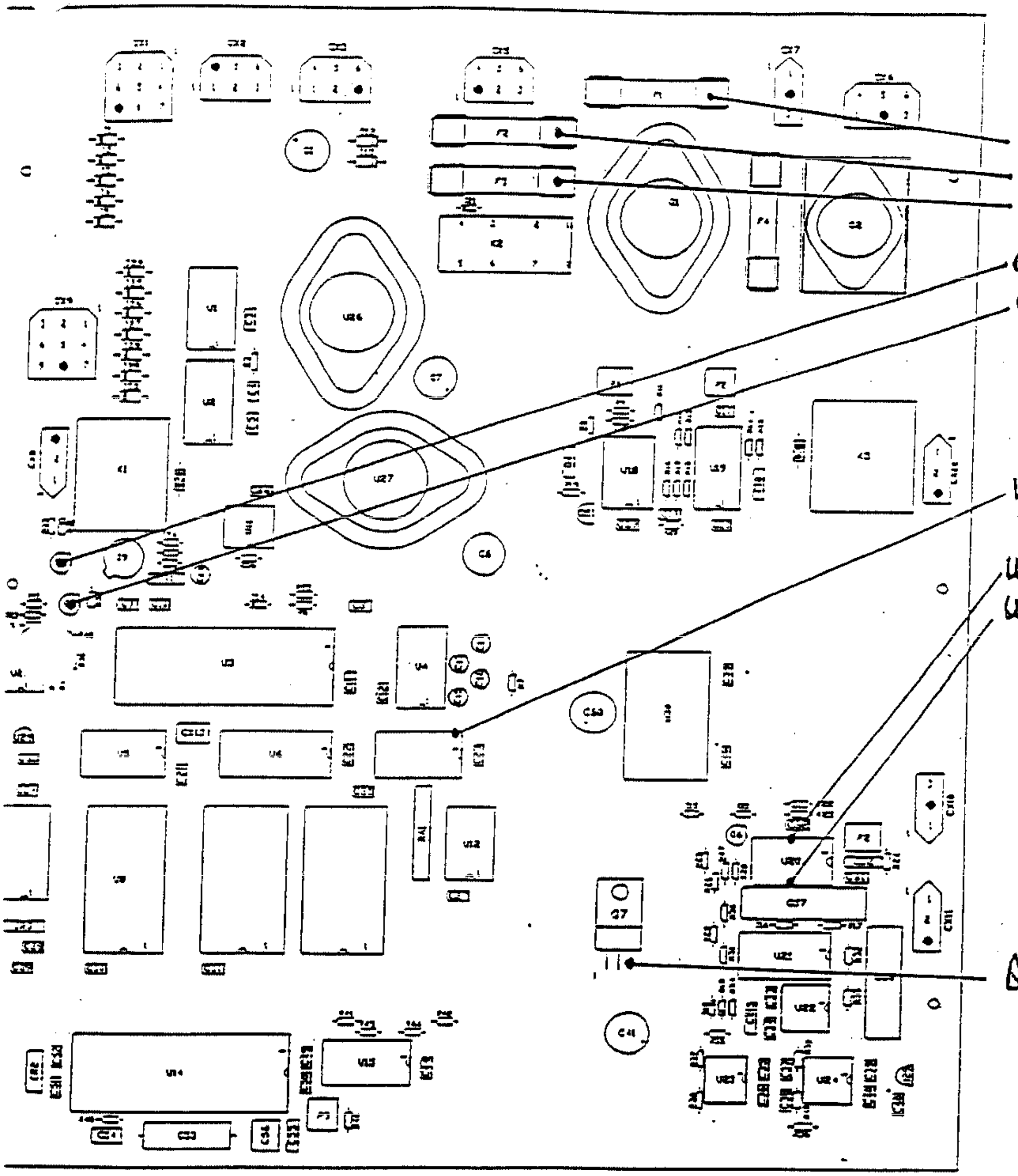

* U7,U9,U10,U13,DCC1,CR3,C23,C28,C29
C63,C25,C26,C31,C64,R52-54,D22
NOT USED IN THIS BOARD
2/9/88
1 CHANGE U11 TO SERIAL EEPROM
2 CHANGE CX9 TO 9 PIN CONN
3 ADD COMPUTER CONTROL OF POWER ON/OFF
4 ADD RESISTORS R2,55,56
5 ADD DIODES D24-31
REMOVE DIODES D6-11
6 REMOVE RESISTORS R3,4
7 U7,U9,U10,U13,DCC1,CR3,C23,C28,C29
C63,C25,C26,C31,C64,R52-54,D22
NOT USED IN THIS BOARD
4
9/16/87
UPDATE PART NUMBERS
3
9/3/87
RAM BATTERY BACKUP
2
7/3/87
RELAY SHUT DOWN
1
DATE
COMMENTS
ROBOTECH INC.
12-20 B RIVER ROAD
FAIR LAWN, N.J. 07410
SENTRY
653 Broad Avenue
Ridgefield, N.J. 07657
G8
11/10/88
XN10GCREV5
N.T.S.
0
1 of 1

Figure 20

SCENTOGRAPH MAIN BOARD



F1 - 11 to 12.5 volts

F2 - 11 to 12.5 volts

F3 - 11 to 12.5 volts

Q3 - 3.9 to 5.2 volts

Q8 - SAME AS F1. F2/F

U7 PIN 1 +5 volts

U20 PIN 4 +15 volts

U20 PIN 11 -15 volts

Q7 PIN 3 +5 volts

Figure 21

M. PREPARING DATA AND PROGRAM DISKETTES

FORMAT NEW DISKS:

Every data disk and program disk must be formatted prior to its use in the SCENTOGRAPH P.C.

TO FORMAT:

STEP I: PRESS '7' **(ENTER)** while in the **OPERATION MENU** to access the UTILITY MENU.

STEP II: PRESS **'9'** **(ENTER)** while in the **UTILITY MENU** to Quit to DOS.

STEP III: At the A:> type FORMAT B: Follow PC Monitor prompts.

STEP IV: When the disk is formatted the message "Format Complete" will appear. Disk is now ready for use as a data disk "B:".

ERASE USED DISKS

To erase used disks proceed as follows:

STEP I: PRESS **'7'** **(ENTER)** while in the **OPERATION MENU** to access the **UTILITY MENU.**

STEP II: PRESS **'6'** **(ENTER)** while in the **UTILITY MENU** to Quit to DOS.

STEP III: At the A> type **"B:"** **(ENTER)**

STEP IV. At the B> type **"DEL *.LOG"** **<ENTER>** followed by **"DEL *.IDX"** **<ENTER>.**

STEP V. When the P.C. monitor displays B> type **"A:"** **<ENTER>.** Disk is now erased and may be used again.

COPY DISKS

To copy a data disk or the program disk to another disk, proceed as follows:

STEP I: PRESS '7' (**ENTER**) while in **OPERATION MENU** to access **UTILITY MENU.**

STEP II: PRESS **'6'** (**ENTER**) in **UTILITY MENU** to Quit to DOS.

STEP IV: At the prompt A>, type

(i) "**DISKCOPY A: B:**" <**ENTER**> if you wish to copy the "A" Disk

OR

(ii) "**DISKCOPY B: A:**" <**ENTER**> to copy the "B" Disk.

Follow prompts on P.C. monitor to copy disk.

NOTE: THE DISKCOPY UTILITY WILL AUTOMATICALLY FORMAT A NEW DISK.

APPENDIX A

RECHARGING INTERNAL GAS CYLINDERS - CARRIER GAS

When recharging the SCENTOGRAPH Internal Carrier Gas Cylinder, the following steps should be observed.

1) Connect the Gas Cylinder Adaptor (Sentex Part #580GCA or equivalent) to the External Carrier Gas Cylinder. The carrier gas must be HP quality or better. (HP Argon is used for AID and ECD operation. HP Helium is used for ECD, PID and TCD operation.)

2) Turn the SCENTOGRAPH Carrier gas valve (located on the back of the SCENTOGRAPH) off. Ensure that the purge valve on the Gas Cylinder Adaptor is off and the Carrier gas external bottle is off.

3) Attach the 1/8" copper fill tubing (supplied by SENTEX in the Start-up Kit) to the Gas Cylinder Adaptor and the SCENTOGRAPH Carrier gas inlet fitting (on the rear of the SCENTOGRAPH). The large fitting will push into the quick connect fitting on the Gas Cylinder Adaptor. The small fitting is inserted into the SCENTOGRAPH quick connect by holding the collar back on the quick connect and inserting the fitting. With the fitting fully inserted, release the collar. Check both ends of the fill line to ensure that all fittings are tightly connected.

4) Open the SCENTOGRAPH carrier gas valve. Observe the pressure registered on the Carrier Gas Pressure Gauge. Close the SCENTOGRAPH Carrier gas valve.

5) Open the Gas Cylinder Adaptor purge valve and allow the line to purge. Close the purge valve.

6) Open the External bottle valve and observe the pressure reading indicated on the Gas Cylinder Adaptor pressure gauge. Close the External bottle valve and purge the line.

7) If the external bottle pressure is greater than the SCENTOGRAPH internal bottle pressure, continue with the fill procedure. If the pressure is less in the external bottle, exchange the external bottle with a full bottle.

8) Open the external bottle, and the SCENTOGRAPH Carrier gas valve.

9) Wait for the pressure to equalize, then shut both valves.

10) Open the purge valve to purge the fill line. Remove the fill line and open the SCENTOGRAPH Carrier gas valve to resume operation with the SCENTOGRAPH.

NOTE: THE SAME PROCEDURE IS FOLLOWED TO FILL THE CALIBRATION TANK WITH THE EXCEPTION THAT: CALIBRATION GAS IS USED, AND THE FILL LINE IS ATTACHED TO THE CALIBRATION PORT ON THE SCENTOGRAPH. PUTTING CALIBRATION GAS IN THE CARRIER PORT WILL CONTAMINATE THE SYSTEM.

APPENDIX B

CALIBRATION FROM EXTERNAL CALIBRATION CYLINDER

1) For high pressure external calibration cylinders, a regulator (such as SENTEX Calibration GCA# CALSC-04) should be attached to the cylinder.

2) Make sure the external cylinder is shut off, the purge valve on the external regulator is shut off and the Calibration valve on the back of the SCENTOGRAPH is shut off.

3) Attach the copper fill tubing to the external regulator and the SCENTOGRAPH calibration inlet port.

IMPORTANT: DO NOT ATTACHED CALIBRATION GAS TO SCENTOGRAPH CARRIER PORT. THIS WILL CAUSE CONTAMINATION, REQUIRING FACTORY REPAIR.

4) Turn the external calibration cylinder on (3/4 turn). The SCENTOGRAPH calibration gas pressure gauge will indicate the calibration gas pressure entering the SCENTOGRAPH. NOTE: THIS SHOULD BE GREATER THAN 200 PSI.

5) Check the Calibration Gas Flow adjustment.

6) The SCENTOGRAPH is now ready to calibrate from the external calibration cylinder.

APPENDIX B

CALIBRATION FROM EXTERNAL CALIBRATION SAMPLE BAG

1) Turn off the SCENTOGRAPH Calibration value located on the back of the unit.

2) Turn off the SCENTOGRAPH Calibration regulator. This is done by opening the cover and turning the Calibration regulator adjustment screw counterclockwise until it is loose. The Calibration regulator is on the left-hand side of the SCENTOGRAPH, to the left of the Carrier gas regulator.

3) Run several calibrations until the Calibration Pressure Gauge reads zero (0).

4) Attach the external calibration sample bag, filled with calibration gas, to the Calibration port located on the right-hand side of the SCENTOGRAPH. The bag is attached to the port using the supplied Teflon tubing and Teflon connector.

5) When a calibration is run, the SCENTOGRAPH will take the sample from the external sample bag.

APPENDIX B

ADJUSTMENT OF CALIBRATION GAS PRESSURE

1) The Calibration gas pressure can be adjusted when either the internal calibration gas cylinder is turned on or an external gas cylinder is attached to the SCENTOGRAPH and turned on. The Calibration Gas Pressure Gauge must indicate at least 200 PSI to properly adjust the Calibration gas pressure.

2) While the SCENTOGRAPH is sampling in the calibration mode, adjust the Calibration Gas Regulator (with the supplied Allen Key) until a slight positive pressure is felt at the Calibration port on the right-hand side of the SCENTOGRAPH.

APPENDIX C

SWITCHING BETWEEN AID AND ECD DETECTORS

1) Turn the SCENTOGRAPH off.

2) Adjust the eight (8) dipswitches as follows:

(Dipswitches located on the SCENTOGRAPH Main Board)

Switch	1	2	3	4	5	6	7	8
AID Mode	ON	ON	ON	ON	OFF	ON	OFF	OFF
ECD Mode	OFF	OFF	ON	OFF	ON	OFF	ON	ON

3) On the Hi-Voltage Board, insert <P1> connector in the proper orientation for the desired mode of operation.

AID Mode: Base plate and connector in matching directions.

ECD Mode: Base plate and connector in opposing directions.

4) The Resistance Plug <P4> on the Hi-Voltage board must correspond with the desired mode of operation.

AID Mode: Either 512K or 1M plug

ECD Mode: 22M plug

5) Electronic gain (adjusted by R2 on the Hi-Voltage Board) must be set as follows:

AID Mode: Between 0.2 and 0.5 volts

ECD Mode: Between 0.4 and 0.6 volts

6) Start SCENTOGRAPH. For AID operation SCENTOGRAPH can be used immediately. ECD operation requires a minimum of four (4) hours to stabilize the detector prior to operation.

APPENDIX D

DETECTOR GAIN ADJUSTMENT

The detector gain of the SCENTOGRAPH is pre-adjusted for ppm levels of aromatic hydrocarbons. To change the gain of the detector signal, turn the potentiometer located on the Hi-Voltage Board R-2. Measure voltage on Pin 3 of CX10 on the main board of the SCENTOGRAPH. Voltage should not exceed 1.0 volt for AID (normal range is between .2 to .5 volts) as a steady baseline voltage. See Figure 19.

APPENDIX E

PRINTING THE COMPUTER DISPLAY

The computer is equipped with a printer parallel output, which can be connected to most printers using a Centronics connector.

TO PRINT THE SCREEN:

1. Connect the computer to the printer.
2. Turn on the computer.
3. Turn on the printer.
4. Print any display by depressing: SHIFT and PRINT.

APPENDIX F

OPERATION OF THE COMPUTER WHEN DISCONNECTED FROM THE SCENTOGRAPH

In this mode, the computer can be operated to review the Operation Summary only.

TO DETACH THE COMPUTER:

1. Turn the SCENTOGRAPH off.
2. Release the two screws holding the computer.
3. Disconnect the computer charger and RS-232 connector.

TO OPERATE THE COMPUTER:

1. Turn the computer on.
2. Wait for Operation Menu to appear.
3. Recall and manipulate data as directed.

APPENDIX G

OPERATING PROCEDURES FOR SCENTOGRAPH PURGE AND TRAP SYSTEM

The SCENTOGRAPH PURGE AND TRAP SYSTEM is a fully computerized sampling system that automates the necessary steps required for purge and trap analysis and water samples. The operator attaches the tubing and electrical connections, sets the purge option on, and fills the calibration and analysis cups with water samples. A series of three automated calibrations and analyses are taken with the average result of the analysis used for the sample concentration. All results and conditions are stored on floppy disk for later recall and review.

ATTACHMENT OF PURGE AND TRAP TO THE SCENTOGRAPH PURGE LINE

The PURGE AND TRAP unit uses an inert purge gas that is supplied from the SCENTOGRAPH. The Teflon line with a male quick-connect fitting at each end is used to supply the PURGE AND TRAP with purge gas from the SCENTOGRAPH. One end of the purge line is connected to the female quick-connect fitting on the back right-hand side of the SCENTOGRAPH. The other end of the purge line is connected to the lower quick-connect fitting on the PURGE AND TRAP unit.

CALIBRATION LINE

The calibration line is a Teflon line with a male quick-connect fitting on one end and a 1/8 swagelock fitting on the other end. The swagelock is attached to the calibration port on the SCENTOGRAPH and the male quick-connect is fitted to the upper female quick-connect on the PURGE AND TRAP unit.

ANALYSIS LINE

The analysis line is a Teflon line with a male quick-connect fitting on one end and a 1/8 swagelock fitting on the other end. The swagelock fitting is attached to the analysis port and the male quick-connect end is fitted to the middle female quick-connect fitting on the PURGE AND TRAP unit.

ELECTRICAL CONNECTION

The electrical connector cable is plugged into the six-plug outlet on the right-hand side of the SCENTOGRAPH and the side of the PURGE AND TRAP unit. The cable can be plugged in either direction.

NOTE: OPERATION OF THE PURGE AND TRAP REQUIRES THE INTERNAL SAMPLE PUMP SUCTION LINE TO BE DISCONNECTED FOR PROPER OPERATION.

APPENDIX H

1 PPM & 1 PPB (%vol/%vol) Solutions

MAKING CALIBRATION STANDARDS FOR PURGE AND TRAP

ITEMS REQUIRED TO MAKE STANDARDS

Pure distilled water
Pure samples of calibration liquid
2-1 liter stoppered volumetric flasks
1-10 ml. syringe for liquids
1-10 ml. volumetric pipet
1-50 ml. stoppered volumetric flask

Check purity of distilled water by analysis with the SCENTOGRAPH and PURGE AND TRAP. If water contains large peaks or numerous small peaks, boil and retest.

1) Pour approximately 25 ml. of distilled water into the 50 ml. volumetric flask.

2) Draw 5-6 ul. of pure calibration liquid into the 10 ul. syringe and inject into a waste container for calibration liquids. Repeat this process 4 or 5 times to clean the syringe.

3) Draw 7-8 ul. of purge calibration liquid into the 10 ul. syringe and eject all but 5 ul. from the syringe.

4) Inject the 5 ul. sample into the water into the 50 ml. volumetric flask. Inject the sample under the water surface to avoid any sample evaporating into the air. Fill the 50 ml. volumetric flask to the indicator line. MARK THIS AS A 100 PPM STANDARD SOLUTION.

5) Pour approximately 500 ml. of distilled water into the 1 liter volumetric flask.

6) Withdraw 10 ml. of the 100 ppm solution from the volumetric flask and transfer into the 1 liter volumetric flask. Continue to fill the 1 liter volumetric flask to the indicator mark with distilled water.

7) Stopper the volumetric flask and shade by inverting for one minute. LABEL THIS SOLUTION AS A 1 PPM STANDARD SOLUTION.

APPENDIX H

MAKING CALIBRATION STANDARDS FOR PURGE AND TRAP (continued)

1) Pour approximately 500 ml. of distilled water into the second clean 1 liter volumetric flask. Transfer 1 ml. of the 1 ppm solution into the second volumetric flask with the 10 ml. pipet.

2) Fill the second volumetric flask with distilled water to the 1 liter indicator mark. Stopper the volumetric flask and invert several times to mix. LABEL THIS SOLUTION AS A 1 PPM STANDARD SOLUTION.

When using calibration solutions with the SCENTOGRAPH PURGE AND TRAP SYSTEM:

1) The solutions should remain stable for several days if refrigerated.

2) The calibration solution used in the PURGE AND TRAP must be changed with each new analysis solution.

APPENDIX I

USE OF SCENTOGRAPH INJECTION PORT

Direct syringe injections of both gaseous and liquid samples can be accomplished on a SCENTOGRAPH fitted with the OPTIONAL heated injection port.

To perform direct syringe injection of samples, go to the OPERATING PARAMETERS MENU and change the appropriate settings for direct syringe injection. The SAMPLE TIME parameter (parameter 2) is set to zero. Setting the SAMPLE TIME to 0, prevents the sample pump from operating during the syringe injection. When zero ('0') is entered for the sample time parameter, the delay time and desorbtion time are automatically set to zero (parameters 3 and 4) and "INJECTION" is displayed on the menu after parameter 2. These parameters must be set to zero and remain zero when performing syringe injections.

NOTE : SAMPLE TIME, DELAY TIME AND DESORBTION TIME MUST BE SET TO 0 FOR SYRINGE INJECTIONS.

FOR GAS SAMPLES a volume up to 2 cc (cubic centimeters) can be injected. A gas tight syringe should be used for handling the samples. The syringe needle should be 22 - 26 gauge with either a 22° bevel point or a side port tip. The volume to be injected is dependent on the sample concentration. The higher the sample concentration, the smaller the sample injection volume must be to avoid overloading the detector. For sample concentrations between 500 and 5000 PPM, a sample size of 0.5 cc or less should be used. If sample concentration is unknown, start with a smaller size injection and increase injection volume to gain analysis sensitivity. For the lower PPM range (1 - 10 PPM) an injection size of 1 cc can be used. PPB analysis of gas samples would require a sample injection of up to 2 cc. Gas sample injections will produce an injection peak which could cause a large trailing peak on the screen. This can be eliminated by increasing the inhibit time past the end of the initial injection peak.

FOR LIQUID SAMPLES the sample size is much less than that used for a gas sample injection. The SCENTOGRAPH is capable of handling 2μl (micro liter) injections and less dependent on the sample concentration when injecting liquids. The syringe should be a 1 to 10 μl capacity syringe and have a 22 to 26 gauge needle with either a 22° bevel point or a side point tip. For samples with high concentrations, the injection volume should be decreased (less than 1 μl) with an increase in sample concentration. For lower concentration samples, the injection size can be increased to a maximum of 2 μl.

APPENDIX I

USE OF SCENTOGRAPH INJECTION PORT

NOTE: DO NOT INJECT MORE THAN 2 μL OF LIQUID SAMPLE INTO THE SCENTOGRAPH INJECTION PORT. THIS COULD HARM THE COLUMN AND CONTAMINATE THE INJECTION PORT.

For either gas or liquid samples, the injection technique is similar. Enter (4) to perform a calibration injection or (3) to inject an unknown sample. The SCENTOGRAPH screen will display the trace information similar to an automated sample. A message **"PRESS ENTER - INJECT"** will appear in the upper righthand corner. A sample is drawn into the syringe, excess air is purged from the syringe and the volume is adjusted for the appropriate size injection. Once the ENTER key is pressed, immediately guide the syringe needle into the injection port, pushing through the septa and inject the sample. The syringe is then quickly removed from the injection port. It is important that the technique of pressing the ENTER key followed by the syringe injection be conducted rapidly with the same technique followed consistently to insure repeatable results.

NOTE: ACCURACY IN RESULTS WHEN PERFORMING DIRECT INJECTIONS ARE DEPENDENT ON THE OPERATORS INJECTION TECHNIQUE.

When ready to resume sampling with the internal sample pump, the SAMPLE TIME, DELAY TIME and DESORBTION TIME must be reset to the appropriate values. If a preconcentrator is used the DELAY TIME should be set to a minimum value of 0.5 seconds and the DESORBTION TIME set to 4 seconds. If a sample loop is used, both DELAY and DESORBTION parameters are set to 0 seconds.

NOTE : WHEN RESUMING USE OF THE INTERNAL PRECONCENTRATOR OR THE INTERNAL SAMPLE LOOP, THE SAMPLE TIME, DELAY TIME AND DESORBTION TIME PARAMETERS MUST BE SET TO THE APPROPRIATE VALUES.

After the parameters are properly set, the SCENTOGRAPH is ready to operate. Since the parameters have been changed, the SCENTOGRAPH will require a calibration prior to performing sample analysis.

APPENDIX J

TEST PROCEDURE FOR CHECKING OPERATION OF SCENTOGRAPH

Please follow these procedures before calling SENTEX for operating problems, many of the test results will be required to correct problems in the operation of the SCENTOGRAPH.

Tools required for checking SCENTOGRAPH:

1. Small screwdriver.
2. 7/16 inch open end wrench
3. 5/16 inch open end wrench
4. Voltmeter that reads 0.01 volts to 300 volts DC.
5. 1/8 inch cap fitting supplied in start-up kit.
6. 5/32 inch Allen Key supplied in start-up kit.
7. Bottle of SNOOP for leak checks.
8. Flowmeter

NOTE: USE ONLY HP GRADE CARRIER GAS.
FOR THE AID, USE HP ARGON.
FOR THE ECD, HP ARGON OR HP HELIUM MAY BE USED.
FOR THE PID AND TCD, USE ONLY HP HELIUM.

NOTE: WHEN THE SCENTOGRAPH IS EQUIPPED WITH A PRESSURE SWITCH, COLUMN PRESSURE MUST BE AT LEAST 8 PSI TO ACTIVATE THE SCENTOGRAPH.

TEST PROCEDURE

1) CHECK CARRIER GAS
Observe that there is a minimum of 200 PSI carrier gas pressure. If the carrier gas pressure is less than 200 PSI, refill the carrier gas.

2) CHECK CALIBRATION GAS
Check the calibration gas pressure. Proper operation of the SCENTOGRAPH requires a minimum of 100 PSI calibration gas pressure for internal calibrations.

3) CHECK FOR LEAKS
Turn carrier gas off. Remove column and block the inlet bulkhead connector with a cap fitting. Turn carrier gas on. Adjust the carrier gas regulator with the supplied Allen Key to obtain a column pressure of 30 PSI. Turn the regulator adjustment counterclockwise until the allen screw is loose in the regulator. Check the column pressure. Wait five minutes and recheck the column pressure. A pressure drop indicates a leak in the system. Check all of the fittings between the regulator and the column with SNOOP. Once the leak has been fixed, turn the carrier gas off, remove the cap fitting and replace the column. Turn the carrier gas on and check the column fitting for leaks.

4) CHECK RS-232 CONNECTION

Ensure that the RS-232 connector is firmly attached to the COMM 1 port of the computer.

5) CHECK THE MAIN BOARD FUSES AND BATTERY VOLTAGE

With the SCENTOGRAPH off and the battery charger disconnected, check the voltage on both ends of fuses F1, F2, and F3. Attach the ground of the voltmeter to any copper tubing in the SCENTOGRAPH and use the probe of the meter to test the voltages. Readings should be the same at both ends (see Checklist). If there is no voltage on any of the fuses, check the fuse in the on-line fuse holder under the left side of the main circuit board.

6) CHECK CHARGER VOLTAGE

Check the voltage across the charger output plug with the charger plugged into a 110 volt supply. The reading should be between 14 and 15 volts. If there is no reading replace the fuse in the charger and recheck the voltage.

7) CHECK MAIN CIRCUIT BOARD VOLTAGES

With the SCENTOGRAPH off and the charger disconnected, measure the voltage on the outer shell of Q8. Measure the voltage on the outer shell of Q3.

BATTERY AND MAIN BOARD VOLTAGES

(Refer to Figure 21 for location of test points)
SCENTOGRAPH off and charger disconnected -

F1	:	11.5 - 12.5 volts
F2	:	11.6 - 12.5 volts
F3	:	11.6 - 12.5 volts
Q8	:	11.6 - 12.5 volts
Q3	:	3.9 - 5.2 volts
Battery Charger	:	14 - 15 volts

8) CHECK OPERATING VOLTAGES

Connect the battery charger to the SCENTOGRAPH and turn the SCENTOGRAPH on. Observe that communications between the SCENTOGRAPH and the computer have been established (displayed on the screen). From the Main Menu, go to the Utility Menu (Press "7"), choose option (Press "1") SET SYSTEM DEFAULTS. Observe that the ANALOG DATA is set to 1 (IF NOT 1 - PRESS <ENTER>, PRESS "9" AND <ENTER>. At the DOS PROMPT (A:\>), type "SNX 1" and PRESS <ENTER>. Press <ENTER> to return to the Utility Menu, Press "9" and <ENTER> to return to DOS. At the DOS prompt, (A:\>), type "SNX X" and Press <ENTER>. This will adjust the program speed parameter and restart the program.

8) CHECK OPERATING VOLTAGES (continued)

When completed, shut the SCENTOGRAPH off for two minutes and restart the instrument. When communications are established and the SCENTOGRAPH Operating Menu appears, move the computer to the side so that voltages on the main board may be checked. Check voltages at the following locations:

(Refer to Figure 21 for location of test points)
SCENTOGRAPH on and charger connected.

F1		: +11.6 - 14.5	- main board
F2		: +11.6 - 14.5	- main board
F3		: +11.6 - 14.5	- main board
U7 socket	pin 1	: + 4.8 to +5.2	- main board
Q7	pin 3	: + 4.8 to +5.2	- main board
U20	pin 4	: +14.7 to +15.3	- main board
U20	pin 11	: -14.7 to -15.3	- main board
P3	pin 1	: + 4.8 to +5.2	- hi-voltage board
P3	pin 3	: + 7.8 to +8.2	- hi-voltage board
P1	pin 3	: over 150 volts	- hi-voltage board

9) CHECK OPERATING PARAMETERS

The following operating parameters are standard parameters for testing the operation of the SCENTOGRAPH:

NOTE: PARAMETERS LISTED FOR A 6' SP1000 COLUMN, BTX CALIBRATION GAS, BATTERY CHARGER PLUGGED IN, CARRIER GAS AND CALIBRATION GAS TURNED ON AND COLUMN PRESSURE SET TO 28 PSI.

NOTE: DO NOT CHECK OPERATION OF UNIT USING SYRINGE INJECTION.

OPERATING PARAMETERS (INITIAL SCREEN)

Sample Time *	: 10 sec		
Delay Time *	: 0.5 sec		
Desorbtion Time *	: 4.0 sec		
Inhibit Time	: 30 sec		
Oven Temperature	: 80 deg. C.		
Chart Time	: 10 min		
Analysis per Calibration	: 99		
Autoanalysis Time	: 0 (Manual)		
Backflush Option	: 0 (Off)		
Number of Peaks	: 3		
peak number	: 1	2	3
compound	: BENZENE	TOLUENE	XYLENE
calibration range	: ppm	ppm	ppm
calibration concentration	: 1.40	1.40	1.40
alarm level	: 2.00	2.00	2.00
second alarm level	: 5.00	5.00	5.00

* Parameter settings for Sample Time, Delay Time and Desorbtion Time are for a SCENTOGRAPH equipped with a preconcentrator. For SCENTOGRAPH equipped with a **SAMPLE LOOP**, Parameters are:

Sample Time : 5 sec
Delay Time : 0 sec
Desorbtion Time : 0 sec

Other parameters remain the same.

OPERATING PARAMETERS - SECONDARY SCREEN

Final Temperature : 80 deg. C.
Temperature Program Duration : 0 sec
Display Magnification : 1.00
Time Weighted Average : 0 hrs
Enable Alarm : 0 (Off)
Enable External Purge : 0 (Off)

SYSTEM DEFAULTS (found on UTILITY MENU)

Data Disk : B (for 2 disk drive computer)
C (for hard drive computer)
Analysis Peak RT Tolerance : 3
Analog Data : 1
Noise Threshold : 300
Print Peak : 0

Changing the STANDARD PARAMETERS will affect the operation of the SCENTOGRAPH. Operating Parameters are not changed for various analysis. If the SCENTOGRAPH does not function properly, reset the Parameters to the standard values and operate the SCENTOGRAPH.

10) CHECK AID/ECD SETTINGS

Dipswitch settings are as follows:
(Dipswitch is U21 on Figure 21)

	AID MODE	ECD MODE
Switch 1	on	off
Switch 2	on	off
Switch 3	on	on
Switch 4	on	off
Switch 5	off	on
Switch 6	on	off
Switch 7	off	on
Switch 8	off	on

Voltage polarity is set by the orientation of P1 on the Hi-Voltage Board. For AID operation, the connector P1 is inserted matching the position indicated by the connector base for P1. For ECD operation, P1 is inserted backwards onto the connector base.

11) CHECK ELECTRONIC GAIN AND HI-VOLTAGE BOARD OPERATION

AID Mode : 0.2 volts
ECD Mode : 0.6 volts

Voltage is adjusted by slowly turning the potentiometer R2 on the Hi-Voltage board. The voltage is measured at pin 3 of CX10 on the main board. Check the voltage drop by pulling connector P1 from the Hi-Voltage board while measuring pin 3 on CX10, the reading should drop to 0.

12) CHECK THE FILAMENT VOLTAGE

The filament voltage is checked by measuring the voltage during the "HEAT FILAMENT" cycle for which a calibration or analysis cycle has to be activated. The voltage is measured at CX7 pin 3. For a TENAX packed preconcentrator, the voltage should be set to 2.90 volts. For a CARBOSIEVE packed preconcentrator, the voltage is set to 7 volts (the filament should barely glow red during the heating cycle). The voltage is adjusted by potentiometer P1 on the main board. Any adjustments to the voltage can only be measured during the heating cycle. Improper voltage settings may damage the preconcentrator packing.

FILAMENT VOLTAGE: TENAX : 2.9 volts
CARBOSIEVE : 7.0 volts

13) CHECK SAMPLING FLOW RATE

Check the flow rate of the pump by attaching the output of a flowmeter to the analysis port. Run an analysis. During the sampling cycle, check the flow rate indicated on the flowmeter. The flow rate should be between 60 and 80 milliliters per minute.

14) CHECK FOR LEAKING VALVES

TEST 1

Check for leaking valves by disconnecting the preconcentrator Teflon tube from the sample pump tygon tube. Use SNOOP to check for any bubbles coming from the Teflon tube. Bubbles indicate a leaking valve. The same procedure should be performed while the SCENTOGRAPH is in the sampling cycle (MAKE SURE THE PUMP IS DISCONNECTED).

APPENDIX J

TEST 2

Check for leaking valves by disconnecting the sample inlet tube from the preconcentrator (Teflon tubing running from the preconcentrator to the 3-way calibration valve or purge delay valve). Attach a length of tubing to the preconcentrator inlet port and check as in Test 1. Any bubbles coming from the tube indicate a leaking valve. (NOTE: WHEN TESTING DURING A SAMPLING CYCLE, THERE WILL BE BUBBLES GENERATED DURING THE DELAY TIME).

Appendix A, Part 2
RWMC O&MM 9.6
Gas Chromatograph

9.8 Operation of Gas Chromatograph

9.8.1 Precautions and Limitations

1. Ensure adequate amount calibration gas (>700 psi).

2. Ensure adequate amount carrier gas (>1000 psi).

3. Do not exceed 1800 psi on internal gas bottles.

4. Ensure internal gas bottles do not go below 200 psi. This could result in damage to system.

5. Do not remove the cover on the detector housing.

6. Compressed gas cylinders (for carrier and calibration gasses) shall be securely fixed to prevent falling or rolling.

7. Safety glasses shall be worn when working with cylinders (see EG&G Idaho Safety Manual, Section 9.3.5, Compressed Gas Safety).

8. Excess vapor from gas standard preparation shall be vented through a hood or other appropriate exhaust system.

9. The gas chromatograph will be used in a well ventilated area. The exhaust from the column and the detector housing shall be vented to a vapor hood or appropriate exhaust system.

10. Analyze sample with concentrations of analytes within the calibration range of the single point calibration.

11. Dilute high concentrations samples to the range of the calibration point.

9.8.2 Set-up of Gas Chromatograph (GC)

A. Fill internal gas bottles

1. Connect carrier gas quick disconnect to the "Carrier" port on rear of GC.

2. Open "Carrier" valve on rear of GC.

3. Open valve on top of carrier gas cylinder located in North airlock. Monitor gauge on regulator. Do not let it exceed 1800 psi.

4. Close "Carrier" valve on rear of GC.

5. Close valve on carrier gas cylinder.

6. Bleed off pressure at bleed off valve on carrier gas cylinder.

7. Disconnect at carrier gas quick disconnect on rear of GC.

8. Repeat Steps 1 through 7 using calibration gas cylinder to calibration port on rear of GC.

B. Ensure both valves on rear of GC are open (when valve handles are in horizontal position).

C. Ensure Computer Battery Charger GC is plugged into rear of GC at proper place.

D. Ensure GC Battery Charger is plugged into rear of GC at proper place.

NOTE: Steps C and D cannot be interchanged because they are different type plugs.

9.8.3 Start the Gas Chromatograph System

NOTE: The GC system is comprised of the GC, the controlling PC, and an external pumping station. For reference, see the Operator's Manual for Scentograph and Scentoscan.

a. Open the carrier gas (argon) valve and the calibration gas (mixture of gases) valve located on the back panel. Verify that both gas cylinders are full by inspecting the pressure gauges when the valves are opened. Maximum pressure for each is 1800 psi. If pressures are below 300 psi, fill the internal cylinders from the bottles supplied, as specified in the Operator's Manual for Scentograph and Scentoscan.

b. Ensure the column pressure gauge, is reading <20-30 psig.

NOTE: After turning both gas bottles on, wait five minutes before continuing.

c. Turn on the GC by releasing the two spring screws on the top cover, lifting the cover, and turning the power switch of the PC to the "ON" position. The switch is located on the rear panel of the PC. The PC will automatically power the GC. The following message will momentarily be displayed on the PC monitor following program loading:

```
SENTEX *********  SCENTOGRAPH.
```

The following menu will then be displayed on the monitor:

```
***Scentograph 1.00             Operation Menu

           Operating Parameter . . . . . . . . .1
           Automatic Operation . . . . . . . . .2
           Analysis Run  . . . . . . . . . . . .3
           Calibration Run . . . . . . . . . . .4
           Analysis Summary. . . . . . . . . . .5
           Chromatograph Review. . . . . . . . .6
           Program Utility Menu. . . . . . . . .7
           Reset Alarm . . . . . . . . . . . . .8

                  Enter Function. . . .?
```

C. Final Conditions

1. The GC is running.

2. Daily sampling is ready to start (as desired).

9.8.4 Analysis Conditions for the Gas Chromatograph

A. The instrument shall be calibrated before starting and during the sampling activity as required by the sampling and analysis plan.

1. Press "4" on the operations menu.

2. Press "Enter", (The internal pump will automatically take an aliquot from the internal calibration cylinder and start the calibration analysis).

B. Analysis of field standards.

1. Attach field standard container to the analysis port.

2. Press "3" on the operations menu.

3. Press "Enter".

4. Type the name of the standard in the space provided (e.g., for a 55 ppm standard, type "STD-55ppm").

5. Press "Enter".

NOTE: If the standard is not within plus or minus 20% of the calibration point, run another field standard (Repeat Steps 2 through 5 above).

C. Analysis of blanks.

1. Press "3" on the operations menu.

NOTE: Internal pump will take a sample of the room air.

2. Press "Enter".

3. Type "Blank" in the space provided.

4. Press "Enter".

NOTE: Blanks will be run after a high concentration sample has been analyzed. This will ensure that the detector has not been contaminated with the gas sample.

D. Analysis of samples.

1. Attach the sample container to the analysis port.

2. Press "3" on the operations menu.

3. Press "Enter".

4. Type the sample number in the space provided.

5. Press "Enter".

6. Repeat Steps 1 through 5 for the remaining samples.

E. Dilution of samples.

This is performed per Section 9.1.6.3 of the RWMC O&MM.

F. Final Conditions.

Samples have been analyzed.

9.8.5 Manual Shutdown of Gas Chromatograph System

1. Shut down the GC as follows:

    a. Close calibration gas and the carrier gas valves (counterclockwise one-quarter revolution). The GC gauge will still maintain a reading until the system completely depressurizes itself.

b. Release the two spring screws on the top cover of the GC and open. Turn off the PC using the switch located at the rear left (facing front) of the PC. The GC will automatically shut down.

NOTE: If the system is to be shut down for more than 24 hours, unplug the power sources for the GC and the PC.

2. Perform GC data management procedures as follows:

a. The PC is equipped with a hard disk (C drive) and a 3.5-in. floppy disk (A drive). The hard disk contains the system applications and cannot be removed. The 3.5-in. floppy disk in the A-drive stores data (i.e., date, time, analysis results, well number, port number, dilution factor) and should be replaced with a new formatted disk every one hundred (100) runs. When the disk is removed, remove its write- protect tab and send the disk to ARDC. Sample activity information will be recorded in the VVE Operations Logbook.

b. Follow the steps below to format a new 3.5-in floppy disc:

(1) Press "7" in the Operation Menu and then "Enter" to access the Utility Menu.

(2) Press "9" in the Utility Menu and then "Enter" to return to DOS.

(3) At the "C> prompt" type the following:

"format A:"

(4) When the floppy disk is formatted, the message "format complete" will appear. (The disk is now ready for use as a data collection disk in the A drive).

(5) When "format another (Y/N)" appears on the screen, type "N" and then "enter."

(6) At the "C> prompt," type the following:

"SNX"

System returns to the Operation Menu to continue sample analysis.

9.8.6 Abnormal Operations of Gas Chromatograph

A. Conditions

1. Retention time not normal.
2. Peaks too small (less than 3/4-in. high).
3. High noise levels (small or large peaks not recognized).
4. No base line on computer screen.
5. Straight line on analysis run.

6. Peak shown on room blank.

B. Procedure

1. Retention time not normal

   Retention time is set by adjusting the column pressure, refer to Sentex Operating Manual.

2. Peaks too small

   Adjust the voltages, refer to Sentex Operating Manual.

3. High noise levels

   Detector probe is dirty. Send the machine back to the factory for cleaning. A certified shipper will follow the guidelines.

4. No base line on computer screen

   Reboot computer by using "SNX X" to adjust computer speed.

5. Straight line on analysis run

   Ensure Tedlar bag is open.

6. Peak shown on room blank

   Residual gas is in column. Run room blanks until it clears up.

9.8.7 Weekly Maintenance

Cleaning the column housing and the detector housing to remove dust particles that off-gassed Tritium may adhere to.

1. Don latex gloves.

2. Using a water dampened Kimwipe (or equivalent), wipe off the column housing and the detector housing.

3. Dispose of gloves and rags as radioactive waste.

NOTE: Proper precautions shall be taken to avoid the spread of potential Tritium contamination when cleaning the instrument or changing the column. The latex gloves and material used to clean the instrument shall be treated as radioactive waste. The operator shall not eat, drink, smoke or engage in any other action that could result in internal potential contamination of the operator while performing weekly maintenance.

Appendix A, Part 3
Dilution Standards and Samples in Tedlar Bags

APPENDIX A

3. DILUTION OF HIGH CONCENTRATION GAS STANDARDS AND SAMPLES IN TEDLAR BAGS

(ETSOP-57)

1. PURPOSE AND SCOPE

The purpose of this standard operating procedure is to standardize the dilution procedure for highly concentrated gas standards and samples analyzed by gas chromatography (GC).

2. ACRONYMS/DEFINITIONS

ETSOP	Environmental Technology Standard Operating Procedure
GC	gas chromatography

3. DESCRIPTION

Often times, the gas standards and samples received from the field exceed the calibration range of the GC. Those samples need to be diluted using a standardized procedure so reliable and accurate concentration results can be obtained.

4. PRECAUTIONS/LIMITATIONS

Safety Considerations

Gas standards and the GC carrier gas used to calibrate and perform analysis on the GC are in pressurized cylinders. The cylinders should be securely fixed and safety glasses should be worn when working with the cylinders.

When preparing standards and samples for dilutions, the excess vapor should be drawn through a vapor hood or exhaust system.

Limitations

If the samples are diluted beyond the range of the calibration point, the results will be compromised. It is best to dilute the samples to within the range of the calibration.

Great error may be introduced if the sample must be diluted over 100-fold. To reduce dilution error, use graduated series of gas-tight syringes.

5. PREREQUISITES

Determine the calibration point to define the dilution range.

6. CALIBRATION AND STANDARDIZATION

Refer to RWMC O&MM 9.8 and the sampling and analysis plan (EG&G-WM-10175) for calibration of the GC.

7. MATERIALS AND EQUIPMENT

- 1-L Tedlar bags
- Luer lock gas-tight syringes (5, 10, 25 and 50 mL - Hamilton[a] or equivalent)
- 22-gauge side port needles
- Certified gas standards.

---

[a] Mention of specific products and/or manufacturers in this document implies neither endorsement or preference, nor disapproval by the U.S. Government, any of its agencies, or EG&G Idaho, of the use of a specific product for any purpose.

8. INSTALLATION

Not applicable.

9. PROCEDURE

1. Fill a labeled Tedlar bag with a measured amount of the standard or sample to be diluted.
2. Attach a side port needle to a gas-tight syringe with a luer lock valve.
3. Rinse the syringe three times by inserting the needle through the valve on the Tedlar bag.
4. Pull back slowly on the plunger to fill the syringe with the standard or sample.
5. Expel the standard or sample to an exhaust to outside ambient air.
6. Fill the syringe beyond the desired injection volume.
7. Adjust to the desired volume, pressurizing the syringe.
8. Open the luer lock valve to equilibrate the pressure.
9. Inject the standard into a clean, labeled Tedlar bag.
10. For a 5x dilution (4:1), rinse the syringe three times with dilution gas (room air) as explained above. Add four volumes of air equal to the initially measured volume of standard added to the Tedlar bag.

10. CALCULATIONS

Not applicable.

11. DATA REDUCTIONS

Not applicable.

12. DATA REPORTING

Not applicable.

13. METHOD PERFORMANCE

An engineering design file shall contain method verification data taken from the Sentex Scentograph on August 6, 12, and 13, 1991, at the Radioactive Waste Management Complex.

Preliminary testing of this procedure indicates that the reproducibility of the dilution method is excellent. The average recovery of carbon tetrachloride from a 10x dilution of a 242-ppm standard prepared six times was 19.80 ppm (81.82%). Each bag was run two times. The relative standard deviation for the 12 runs was 7.51%.

Dilution of other standards showed excellent reproducibility. The precision for each set of runs at each dilution was always <10% (% relative standard deviation). The accuracy was variable during preliminary tests. Average recoveries ranged from 64% to 98%. Poor recoveries (<80%) are attributed to dilutions prepared at a concentration much less than the calibration point.

14. REFERENCES

EG&G Idaho Safety Manual, Section 9.3.5.

Appendix B, Part 1
Monitoring with Ionization Detector

APPENDIX B

Monitoring Organic Vapors Using a Portable Ionization Detector
(ETSOP-40)

APPENDIX B

Contents

APPENDIX B
MONITORING ORGANIC VAPORS USING A PORTABLE IONIZATION DETECTOR
(ETSOP-40)

1.0 PURPOSE AND SCOPE

The Portable Ionization Detector will be used to measure real-time, total volatile organic concentration levels of volatile organic vapors in air.

2.0 PROCEDURES

2.1 PREREQUISITES

Before beginning any operation, check the maintenance tag to ensure the maintenance is up to date.

2.2 GENERAL QUALITY ASSURANCE/QUALITY CONTROL CONSIDERATIONS

As with any field instrument, accurate results depend on the operator being completely trained and familiar with the operator's manual for the unit in use. The validity of the data is highly dependent upon the technique of the sampling person. Care should be taken to follow the procedures outlined in this SOP as closely as possible. The operator's technique should be reviewed and approved by a qualified operator and this qualification should be documented.

2.3 HEALTH AND SAFETY REQUIREMENTS

Specific operational safety requirements for operating and performing maintenance on this instrument will be addressed in the supervised training addressed in section 2.4.

2.4 TRAINING

Personnel assigned to perform this procedure will be briefed by the field team leader in the use of the procedure, limitations, and safety considerations specified in this procedure. Equipment-specific operation and maintenance procedures will be read and understood. Personnel operating the machinery will receive at least one day of supervised training with the instrument. All training will be documented and approved.

2.5 PRECAUTIONS/LIMITATIONS

PRECAUTIONS. Safety Considerations. Some models are equipped with an alarm to warn of preset concentrations of potentially hazardous gases. The alarm must be set at the recommended level. If the instrument alarms, evacuate the area and notify emergency personnel. The health and safety section of the sampling and analysis plan (SAP) and/or separate health and safety plan and/or safe work permit must be consulted prior to the start of any activity.

LIMITATIONS. A photoionization detector (PID) will respond to most vaporous compounds in air that have an ionization potential less than or equal to that supplied by the ionizing source in the detector (i.e., an UV lamp). The magnitude of the response is a function of the detector sensitivity and the concentration and ionization properties of the individual compound.

Although the PID can be calibrated for a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases. Therefore, the PID indicates an integrated response, which is a function of the response factors and concentrations of all ionizable species present in the sample. Interferences because of high humidity or moisture have been observed, mainly because of interference of the water molecules.

2.6 MATERIALS AND EQUIPMENT

Not Applicable

2.7 CALIBRATION/STANDARDIZATION

Frequency. Calibrate as directed in the operating manual or before each use.

Who Performs. The instrument operator should perform the calibration and document the results in the appropriate log.

Criteria for Timing. Calibration requirements may vary with frequency of use or with compounds measured. Consult operating manual for details.

Procedures. See manuals for individual instruments. Calibration for specific compounds can be performed so that the instrument response is proportional to the calibration gas concentration.

2.8 TRANSPORTATION

Not applicable.

2.9 PROCEDURE DESCRIPTION

These procedural steps are intentionally general. The operating manual for the PID in use should be consulted for specific instructions.

1. Check battery charge level. If in doubt, charge battery as described in manual.

2. Turn unit on. Verify operation of UV lamp (equipment-specific).

3. Perform zero and calibration procedures as described in the operating manual.

4. If so equipped, set alarm at recommended level to warn of hazardous concentrations.

5. Once calibrated, the unit is ready to use.

6. Position the intake assembly in close proximity to the area to be sampled as the statement of work sampling rate allows only for very localized readings.

7. Use a slow sweeping motion of the intake assembly to help prevent bypassing contaminated areas.

8. Be prepared to evacuate the area if the detector alarms.

<u>Principle of Operation</u>. The instrument analyzer operates on the principle of photoionization for detection total volatile organic vapors. This process is termed "photoionization" because a molecule absorbs ultraviolet (UV) light, leading to ionization.

The detector contains a sealed UV light source that emits photons with sufficient energy to ionize trace levels of many organics, but of insufficient energy to ionize the major components of air (O_2, N_2, CO_2, or H_2O). A chamber adjacent to the UV light source contains a pair of electrodes. When a positive potential is applied to one electrode, the created field drives any ions formed by absorption of UV light to the collector electrode, where the current (proportional to concentration) is measured. This signal is amplified and conditioned and then sent to the output display.

2.9.1 COMMON PROBLEMS AND SOLUTIONS

Certain toxic gases and vapors with high ionization potentials (i.e., carbon tetrachloride) may not be detected with a PID, depending on the light source used. In certain instances, a PID may be more valuable in combination with other types of detectors.

Static voltage sources such as ac power lines, transformers, or radio transmission may interfere with measurements. Humidity and moisture can also interfere, especially when using high-eV lamps

(11.7 eV). See the equipment-specific operation and maintenance manual for a discussion of the necessary considerations.

2.9.2 SPECIAL MAINTENANCE

Regular cleaning and maintenance of the instrument and accessories, according to the equipment-specific operation and maintenance manual, will ensure representative readings. When in use, keep the instrument out of the direct sunlight, if possible.

2.10 DATA REDUCTION, CALCULATIONS, AND REPORTING

Data Reduction and Calculations is not applicable in this SOP.

Reporting: In addition to the data specified in the "Scope" section of this standard operating procedure (SOP), always record the date, the time of sampling, personnel performing the sampling, calibration data, and any other events associated with the sampling. The SAP will outline record keeping requirements in detail.

2.10.1 DATA REDUCTION

Not applicable.

2.10.2 DATA REPORTING

Units. Usually in ppm, but refer to equipment-specific operation and maintenance manual and SAP for details.

Precision. The precision of the PID can be checked by periodically using the calibration gas as a measurement. Refer to the equipment-specific operation and maintenance manual for details.

Accuracy. As above.

3. REFERENCES

U.S. Environmental Protection Agency, Characterization of Hazardous Waste Sites-A Method Manual: Volume II, U.S. Environmental Monitoring Systems Laboratory, P.O. Box 15027, Las Vegas, Nevada 89114-5027, EPA-600/4-8340-040.

Equipment-specific manufacturer's operation and maintenance manual.

NOTE: THE EQUIPMENT-SPECIFIC OPERATION AND MAINTENANCE MANUAL MUST ALWAYS BY USED WITH THIS ETSOP.

Appendix B, Part 2
Air Monitor/Photo-Ionization User's Manual

MiCROTiP MP-1000

Hand Held Air Monitor/Photoionization Detector

User's Manual

Photovac International Incorporated

25-B Jefryn Boulevard West
Deer Park, New York
11729
Telephone: (516)254-4199
Fax: (516)254-4284

PHOTOVAC

Photovac Incorporated
105 Doncaster Avenue
Thornhill, Ontario
Canada L3T 1L6
Telephone: 416-881-8225
Fax: 416-881-3961
Telex: (USA)7608242
Telex Answerback: PHOTO

Part No. 395024

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WARNING

THIS EQUIPMENT GENERATES, USES AND CAN RADIATE RADIO FREQUENCY ENERGY AND IF NOT INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTION MANUAL, MAY CAUSE INTERFERENCE TO RADIO COMMUNICATIONS. IT HAS BEEN TESTED AND FOUND TO COMPLY WITH THE LIMITS FOR DOC STANDARD C108.8 AND FOR A CLASS A COMPUTING DEVICE PURSUANT TO SUBPART J OF PART 15 OF FCC RULES, WHICH ARE DESIGNED TO PROVIDE REASONABLE PROTECTION AGAINST SUCH INTERFERENCE WHEN OPERATED IN A COMMERCIAL ENVIRONMENT. OPERATION OF THIS EQUIPMENT IN A RESIDENTIAL AREA IS LIKELY TO CAUSE INTERFERENCE IN WHICH CASE THE USER AT HIS OWN EXPENSE WILL BE REQUIRED TO TAKE WHATEVER MEASURES MAY BE REQUIRED TO CORRECT THE INTERFERENCE.

Chapter 1 Introduction

1.1 UNPACKING

Included with the instrument you will find the following standard accessories:

- User's Manual
- 120/230 Volt Battery Charger
- 17 cm (6.8") Sample Line
- 5 Spare Filter Cartridges
- Shoulder Strap

Remove MicroTIP™ and accessories from the shipping box and examine them for any physical damage. Inform Photovac immediately if MicroTIP or the accessories are damaged.

Instruments being used outside the United States and Canada must have a new plug installed on the battery charger. See Appendix A.

1.2 RECHARGING THE BATTERY

Before beginning operation of MicroTIP, the battery pack must be charged.

Note: Use only MicroTIP battery charger Photovac Part No. 395016 for 110V or 395017 for 220V. Using another MicroTIP battery charger will result in damage to the MP-1000 battery pack.

1. Ensure MicroTIP is off by pressing the front of the power switch. See Figure 1.
2. Set the voltage selector switch on the bottom of the battery charger to the appropriate AC line voltage.
3. Press the release button on the bottom of MicroTIP and remove the battery pack by sliding it backwards. See Figure 1.
4. Plug the charger into the battery pack and then into an AC outlet and allow the battery pack to charge until the red LED on the battery pack flashes slowly.

If the battery pack is fully discharged this will take about 8 hours.

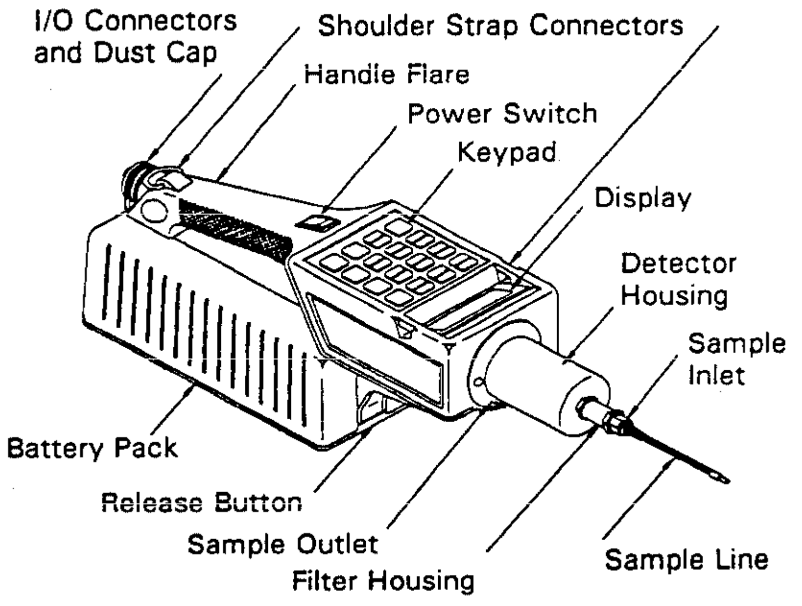


Figure 1 MicroTIP Layout

5. After charging remove the charger, first from the wall outlet then from the battery pack, and slide the battery pack back onto MicroTIP.

The instrument is now fully charged and ready for use.

Chapter 2 Operation

2.1 OVERVIEW

MicroTIP measures the concentration of airborne ionizable gases and vapors and automatically displays and records these concentrations.

MicroTIP does not distinguish between individual pollutants. The reading displayed represents the total concentration of all photoionizable chemicals present in the sample.

```
Warming up now,
  please wait...
```

Turn the instrument on by pressing the back of the power switch. The pump will start and the message "Warming up now, please wait" will be displayed. Within three minutes the following information will appear on the display: instrument status, current detected concentration, Event number (if the datalogger is on), time, and date.

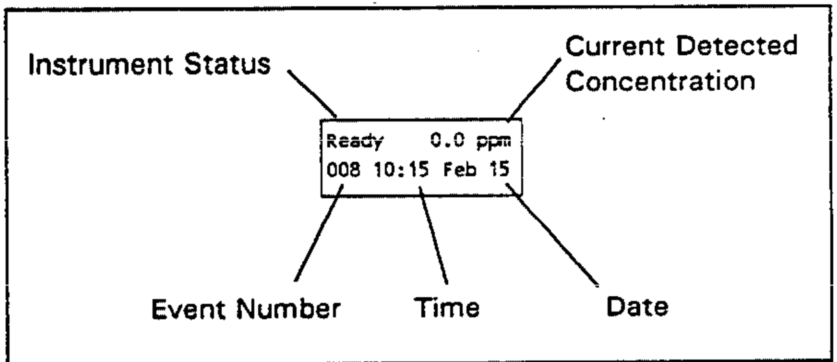


Figure 2 Normal Display

MicroTIP operates automatically. The user reads concentrations directly from MicroTIP's display. The display updates itself each half second.

The Minimum, Maximum, and Average concentrations measured in each 15-second period are automatically recorded in MicroTIP's datalogging memory. MicroTIP's memory holds 12 hours of concentration data.

Concentration data can be played back from memory on MicroTIP's display or sent to a printer or computer in either a tabular or a graphical format. Data are recorded by date, time, and by a sequential Event number. Data are played back by the user specifying a start and a stop Event number.

The keypad is used to set up and calibrate MicroTIP, and allows the user to manipulate the concentrations measured and recorded by MicroTIP in various ways. MicroTIP has 16 clearly labelled keys for direct numeric entry and for using MicroTIP's functions.

All information entered from the keypad and stored in MicroTIP's memory is retained when MicroTIP is switched off. The clock and calender continue to operate and do not need to be reset the next time MicroTIP is used.

2.2 TUTORIAL SESSION

To assist the user in learning the key functions, MicroTIP has a built-in tutorial session which displays a two-line description of the function of each key. Pressing MicroTIP's TUTOR key begins a tutorial session and pressing the EXIT key twice ends the session. While in the tutorial session keypresses have no effect on MicroTIP's operation.

Press the TUTOR key and begin a tutorial session. Press each key and read the display. The tutorial display for each key is given in Table 1.

BATT	Shows battery V normally 6-8.5V	ALARM	Shows set-point for conc alarm
DISPLAY	Displays conc as graph or numeral	MAX	Displays highest conc measured
LIGHT	Shows intensity of detector lamp	SETUP	Sets date time & options for keys
AUDIO	Selects alarm or tone or no audio	EVENT	Sets options for recording data
PRINT	Prints table of recorded data	TUTOR	Press a key then read explanation

Table 1 TUTOR Displays

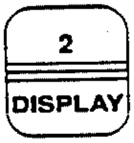
GRAPH	Prints graph of recorded data	CLEAR	Erases the last number pressed
PLAY	Replays recorded data on display	EXIT	Cancels key with no more changes
CAL	Calibrates with zero & span gas	ENTER	Confirms display then continues

Table 1 - continued

If there are no options to the function then the key acts immediately. If there are options, then the current option is displayed on the lower line. The user is prompted to display the other options by pressing the up arrow or down arrow keys. Pressing ENTER confirms that the displayed option is correct. If the function requires numeric input then the current value is displayed on the lower line. The user can change it on the display by pressing the numeric keys. Pressing ENTER confirms that the displayed value is correct.

Some functions have multiple steps for options and/or numeric inputs. These are arranged so that the most frequently changed inputs are displayed first. Once the desired changes have been made the user can bypass the rest of the steps by pressing EXIT.

Each key function is described in more detail in the following sections. Leave MicroTIP on and try each key in turn.



2.3 DISPLAY

If a numerical display is shown, pressing DISPLAY will change it to a bar graph. If the bar graph is shown, pressing DISPLAY changes it to a numerical display. The bar graph range is selected with the SETUP key.

2.4 LIGHT

Pressing the LIGHT key switches the backlighting on to high intensity. The current intensity of the detector UV lamp is alos displayed when the LIGHT key is pressed. Pressing it

GRAPH	Prints graph of recorded data	CLEAR	Erases the last number pressed
PLAY	Replays recorded data on display	EXIT	Cancels key with no more changes
CAL	Calibrates with zero & span gas	ENTER	Confirms display then continues

Table 1 - continued

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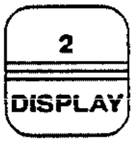
Some functions have multiple steps for options and/or numeric inputs. These are arranged so that the most frequently changed inputs are displayed first. Once the desired changes have been made the user can bypass the rest of the steps by pressing EXIT.

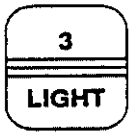
Each key function is described in more detail in the following sections. Leave MicroTIP on and try each key in turn.



```
R0 ███     2000
205 10:15 Feb 15
```

2.3 DISPLAY

If a numerical display is shown, pressing DISPLAY will change it to a bar graph. If the bar graph is shown, pressing DISPLAY changes it to a numerical display. The bar graph range is selected with the SETUP key.



2.4 LIGHT

Pressing the LIGHT key switches the backlighting on to high intensity. The current intensity of the detector UV lamp is alos displayed when the LIGHT key is pressed. Pressing it again decreases the intensity and pressing it again turns the backlighting off. The brighter lighting consumes more power and is recommended for use only in very dark locations.

2.5 BATT

```
Battery level, V
      8.3
```

Pressing the BATT key displays the current battery level. The battery voltage will be shown for 15 seconds and then the display reverts to normal. The normal operating voltage range is 6 to 8.5 volts.

When LoBat is displayed there is approximately 10 minutes of operation left. The battery pack must be replaced by a fully charged pack and the discharged pack should be recharged. See Section 1.2.

```
BATTERY PACK
  CRITICALLY LOW
```

If operation is continued with a low battery pack another message will appear indicating that the batteries are critically low. MicroTIP will now turn off the detector lamp. This reduces deep discharging of the battery pack and possible memory loss.

Note: Deep discharging of the battery pack will result in loss of recorded data and setup parameters. To avoid this, replace the battery pack with a fully charged one and recharge the old one for at least 8 hours.

2.6 MAX

```
Max        112 ppm
240 10:12 Feb 15
```

Press the MAX key. The maximum concentration, the Event during which it was encountered, the time and the date of the occurrence will be displayed. This is shown for 15 seconds and then the display reverts to normal.

```
Press CLEAR
   to reset Max
```

```
Max cleared
240 10:12 Feb 15
```

Pressing any key and then CLEAR will reset the Max register. "Max Cleared" will be displayed with the current date and time. After 15 seconds the display reverts to normal.

Recording of real time data is not interrupted when the MAX key is pressed or when the Max register is cleared.

2.7 CLEAR

CLEAR erases the last numerical entry. If a number is entered in error press CLEAR to erase the entry and re-enter the correct number. CLEAR used in conjunction with the MAX key resets the Max register.

2.8 EVENT

Events may be used to identify a particular sample or sampling location in memory. Recorded data are played, printed and removed from the datalogger by specifying a start and stop Event number.

```
Ready       500 ppm
240  10:28 Feb 15
```

The EVENT key controls MicroTIP's datalogger. When MicroTIP is turned on the datalogger will begin recording and the Event number will be incremented.

```
Event option? ↑↓
Advance Event
```

```
Ready       0.0 ppm
241  10:35 Feb 15
```

Press the EVENT key to see the Event options. The first Event option is Advance Event. To increment the current Event number press ENTER.

```
Event option? ↑↓
Stop recording
```

```
Ready       0.0 ppm
---  10:37 Feb 15
```

Move to the next Event option by pressing the arrow keys. The datalogger can be turned off with the Stop Recording option by pressing ENTER. MicroTIP will continue to display the current detected concentration but no data will be recorded. There will be no event number shown on the normal display. To begin recording again, press EVENT and then ENTER. The Event number is automatically incremented by one when the datalogger is turned on.

```
Event option? ↑↓
Delete Event(s)
```

```
Delete what?  ↑↓
Range of Events
```

```
Start at Event?
        1
```

```
Stop with Event?
241
```

Press the arrow keys to view the next option. The user can delete the current Event, all recorded Events or a range of Events. Press ENTER then use the arrow keys to select the desired option and press ENTER. If a range of Events is to be deleted, MicroTIP will ask for the start and stop Event numbers. To reset the Event counter to 001, delete all the events in the datalogger. After Event 255, MicroTIP resets the Event counter to zero automatically.

```
Ready       0.0 ppm
241  10:40 Feb 15
```

Ensure the correct delete option and Event numbers have been selected. Deleted information cannot be recovered. It is a good idea to playback or print the contents of the datalogger before deleting any information.

Note: MicroTIP only stores the last Event number seen in a 15 second period. To assign an Event number to a sample, the Event number should be advanced only once every 15 seconds. If the Event number is advanced more than once in a 15 second period lower Event numbers will not be stored.

MicroTIP can record continuously for a period of 12 hours. After this time it begins to overwrite existing data one Event at a time. For example: 6 Events of 2 hours each are recorded. Event #7 will overwrite event #1 if it is 2 hours or less in length. If Event #7 is greater than 2 hours it will completely overwrite Event #2 as well. Let's say Event #7 is 3 hours, then Events #3, #4, #5, #6 and #7 are now in the recorder.

If it is necessary to retain a copy of recorded data, the data should be printed or stored in a computer at least once every 12 hours of operation. This will prevent loss of information when events are overwritten.

2.9 EXIT

The EXIT key terminates all MicroTIP functions except DISPLAY. When EXIT is pressed the display reverts to normal. Most functions exit automatically if no key is pressed for 15 seconds.

When EXIT is pressed during printing or graphing, MicroTIP stops sending information to the printer or computer. The printer will continue to print until its buffer is empty.

SETUP

2.10 SETUP

The SETUP key allows MicroTIP to be set up for a specific application. The current date and time are also set with the SETUP key.

Press SETUP and step through the options. Press ENTER to accept the displayed data or enter a numerical value using the keypad and then press ENTER. If no values are entered the display reverts to normal. To set up the instrument:

1. Press SETUP.

```
Range 0-? ppm ↑↓
200
```

2. The first option sets the full scale range for the bar graph display, the graph output, the audio output, and the 1 volt analog output. Use the up and down arrow keys to select the 20, 200 or 2000 parts per million (ppm) range.

```
Cal memory ?  ↑↓
1
```

3. Next the Cal Memory is selected. MicroTIP has 10 Cal Memories for regular operation and one for High Sensitivity operation. Only one Cal Memory can be used at a time. Select Cal Memory 1 with the up and down arrow keys and press ENTER.

   No matter which Cal Memory is selected, MicroTIP's response is not specific to any one compound. The reading displayed represents the total concentration of all ionizable compounds in the sample.

```
Hour is ? 0-23
      10
```

```
Minute is ? 0-59
      45
```

4. Next enter the correct values for the current time. Press ENTER after each value.

```
Date is ? 1-31
      15
```

```
Month is ? 1-12
      2
```

```
Year is ? 0-99
      92
```

5. Enter the numerical values for the day, month and year. Again press ENTER after each selection.

2.11 AUDIO

To connect the headset remove the dust cap from the I/O connector and plug in the headset. If a headset is being used with MicroTIP press AUDIO and use the arrow keys to select one of three options for audio output and press ENTER.

```
Audio output? ↑↓
     Off
```

```
Audio output? ↑↓
Audio on Alarm
```

```
Audio output? ↑↓
Continuous Audio
```

Audio output can be turned off altogether, set so there is audio output during an alarm condition only, or a continuous audio signal with the tone frequency being proportional to the detected concentration. The volume is controlled by a knob on the headset.

2.12 ALARM

The ALARM key displays the current alarm level and allows a new alarm level to be entered.

```
Alarm at ? ppm
    100.00
```

1. Press ALARM to display the current alarm. If this value is correct, press EXIT to return to the normal display.

2. If a new value is to be set, enter the value, and press ENTER.

When an alarm condition is detected the instrument status changes to "Alarm" and an audio signal is heard through the headset (only if "Audio on Alarm" is selected) and remains on until the alarm condition has passed or until it is turned off with the AUDIO key.

2.13 PLAY

The PLAY key plays back previously recorded data. If either "Audio on Alarm" or "Continuous Audio" is selected the playback audio output (not the real time output) is heard through the headset. To enable playback audio output, press AUDIO and select the desired output before pressing the PLAY key.

1. Press PLAY. Two options are available. Pressing ENTER begins playback where it was last stopped. Press the SETUP (*) key to set the playback options.

```
ENTER to Play
    * for Options
```

2. Enter the start Event. If this Event is not available MicroTIP begins at the next higher Event. An Event may not be available if the Event number was advanced more than once in 15 seconds, or if the selected Event has been deleted or overwritten.

```
Play from Event ?
      10
```

3. Next select which value is to be displayed, either the Minimum, the Average, or the Maximum, with the arrow keys and press ENTER.

```
Min Avg Max ? ↑↓
Avg
```

4. The data can be played back in either numerical or graphical display by pressing the DISPLAY key.

When MicroTIP is playing back recorded data it is also measuring and recording real time concentrations even though the instrument status is "Play". If, during playback, an instrument status with a priority higher than that of "Play" is encountered in real time operation it will be displayed, but MicroTIP will continue to play back.

```
Play       100 ppm
010>10:20 Feb 15
```

```
Play       100 ppm
012<10:22 Feb 15
```

Playback speed and direction can be selected using the arrow keys. The speed can be increased or decreased and the information can also be viewed in the opposite direction. A forward arrow (>) appears in the display if data are being played forward or a backward arrow (<) if the data are being played in reverse.

Press ENTER to freeze the display at any time and use the arrow keys to resume playback. Press EXIT to return to the normal display.

The PLAY function provides a speed search to find the desired start and stop Event numbers for printing or graphing.

2.14 CAL

MicroTIP must be calibrated in order to display concentration in units equivalent to ppm. First a supply of zero air, which contains no ionizable gases or vapors, is used to set MicroTIP's zero point. Then, span gas, containing a known concentration of a photoionizable gas or vapor, is used to set the sensitivity.

Usually clean ambient air will be suitable as zero air. If there is any doubt, use a commercial source of zero grade air and a second sampling bag. Span gas of the desired compound and concentration, required for calibration, may be obtained from a specialty gas supplier. See Appendix B.

Isobutylene at 100 ppm in air is recommended as span gas. To calibrate the instrument use the Calibration Kit (Photovac Part No. 390033) as follows:

1. Connect the supplied regulator to the span gas cylinder. Hand tighten the fittings. Observe proper handling techniques for all gases.
2. Open the valve on the gas bag by turning the valve stem fully counterclockwise.
3. Attach the nut to the regulator. Hand tighten the fittings.

4. Turn the regulator knob counterclockwise about half a turn to start the flow of gas.

5. Fill the gas bag about half full and then close the regulator fully clockwise to turn off the flow of gas.

6. Disconnect the bag from the adapter and empty it. Flush the bag a few times with the span gas and then fill it.

7. Close the gas bag by turning the valve clockwise.

```
Cal memory ?  ↑↓
7
```

8. Press SETUP and select the desired Cal Memory with the arrow keys and press ENTER. Press EXIT to leave Setup.

```
Response factor?
    1.00
```

9. Press CAL and enter the desired response factor. Use Table 2 to find the correct response factor. If the compound is not in Table 2 or you are not looking specifically for one compound then enter 1.00.

   The concentration detected by MicroTIP will be multiplied by the response factor before it is displayed and logged.

```
Connect zero gas
then press ENTER
```

```
Calibrating now,
  please wait...
```

10 Expose MicroTIP to zero air. Press ENTER and MicroTIP sets its zero point.

```
Span conc ? ppm
    100.00
```

11. MicroTIP then asks for the span gas concentration. Enter the known span gas concentration and then connect the span gas bag adapter to the inlet.

```
Connect span gas
then press ENTER
```

```
Calibrating now,
  please wait...
```

12. Press ENTER and MicroTIP sets its sensitivity.

13. When MicroTIP's display reverts to normal, MicroTIP is calibrated and ready for use. Remove the span gas bag from the inlet.

MicroTIP has 10 Cal Memories and can be calibrated with 10 different span gases or response factors if desired. Only one Cal Memory can be used at a time. Each memory stores a different response factor, zero point and sensitivity. To program the Cal Memories:

1. Press SETUP and select the desired Cal Memory (1 to 10) with the arrow keys.
2. Exit from SETUP and press the CAL key.
3. Enter the desired response factor and press ENTER.

Note: It does not matter which Cal Memory is selected or which response factor is entered, MicroTIP's response is not specific to any one compound. The reading displayed represents the total concentration of all photoionizable compounds in the sample.

4. Follow the displayed calibration instructions. When the calibration is completed it is automatically stored in the selected Cal Memory. The span gas concentration entered here is specific to the selected Cal Memory.

Whenever the instrument is calibrated, MicroTIP updates the selected Cal Memory only. The instrument should be calibrated at least once a day.

5
PRINT

2.15 PRINT

MicroTIP was designed to be used with an Epson® FX-80 or 100% compatible printer with an RS232 serial interface. If Epson compatible printer is to be used, a different printer cable may be required. See Section 3.1 for details on the type of cable required.

The printer must be set to 8 data bits and 1 stop bit to communicate with MicroTIP. MicroTIP's baud rate and parity must be set depending on the printer requirements. Refer to the printer user's manual for more information.

To print recorded data:

1. Use the printer cable and suitable adapter (Photovac Part No. 395006) to connect the MicroTIP I/O connector to the printer.
2. Press the PRINT key and then the SETUP (*) key to select the desired setup options.

3. MicroTIP will ask for the number of the start and stop Events. Enter the desired values and press ENTER.

4. MicroTIP will then ask if the selected data are to be formatted to fit on one 8½" x 11" page or if all recorded data between the selected start and stop Events are to be printed. Use the arrow keys to select the desired option and press ENTER.

5. Enter an ID number if desired. Any number up to 16 digits long may be entered as an ID number. The ID number can be used to differentiate between users or instruments. If more than one user is using a single instrument, each user will use an individual number for printed reports. If more than one MicroTIP is being used, each instrument can have its own ID number on printed reports.

   If an ID number is not required, leave this option blank and move onto the next option by pressing ENTER.

6. Enter the baud rate and parity. These values are specific to the printer being used and must be set correctly. Again, refer to the printer user's manual to determine the correct baud rate and parity.

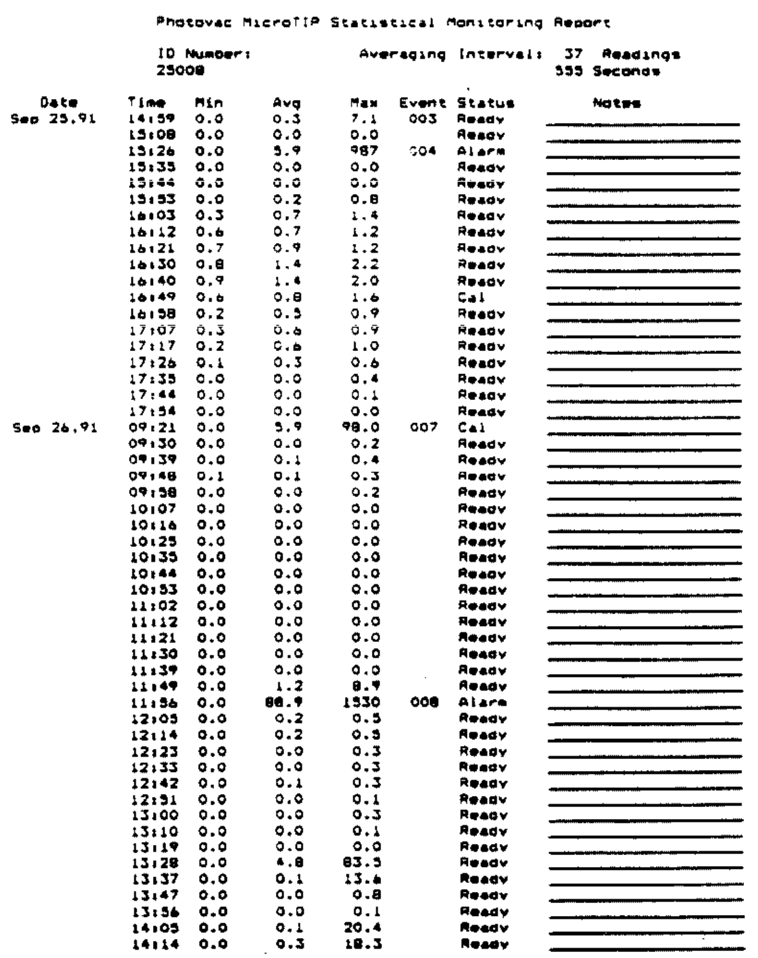
7. When the setup is correct, ensure the printer is on line and press ENTER.

If "Fit on one page" is selected, MicroTIP will divide the selected data into 54 averaging intervals. One interval is printed on each line.

MicroTIP stores one set of readings (Min, Avg and Max) each 15 seconds. In each averaging interval the printed minimum is the minimum of all the stored readings in that interval. The printed Avg is the average of all the recorded average readings and the Max is the maximum of all the recorded maximum readings.

The following information is printed:

a. The number of readings in an interval and the



```
                Photovac MicroTIP Statistical Monitoring Report

                ID Number:              Averaging Interval:  37  Readings
                25008                                        555 Seconds

    Date        Time   Min      Avg      Max   Event Status         Notes
Sep 25,91       14:59  0.0      0.3      7.1    003  Ready     ____________
                15:08  0.0      0.0      0.0         Ready     ____________
                15:26  0.0      5.9      987    004  Alarm     ____________
                15:35  0.0      0.0      0.0         Ready     ____________
                15:44  0.0      0.0      0.0         Ready     ____________
                15:53  0.0      0.2      0.8         Ready     ____________
                16:03  0.3      0.7      1.4         Ready     ____________
                16:12  0.6      0.7      1.2         Ready     ____________
                16:21  0.7      0.9      1.2         Ready     ____________
                16:30  0.8      1.4      2.2         Ready     ____________
                16:40  0.9      1.4      2.0         Ready     ____________
                16:49  0.6      0.8      1.6         Cal       ____________
                16:58  0.2      0.5      0.9         Ready     ____________
                17:07  0.3      0.6      0.9         Ready     ____________
                17:17  0.2      0.6      1.0         Ready     ____________
                17:26  0.1      0.3      0.6         Ready     ____________
                17:35  0.0      0.0      0.4         Ready     ____________
                17:44  0.0      0.0      0.1         Ready     ____________
                17:54  0.0      0.0      0.0         Ready     ____________
Sep 26,91       09:21  0.0      5.9     98.0    007  Cal       ____________
                09:30  0.0      0.0      0.2         Ready     ____________
                09:39  0.0      0.1      0.4         Ready     ____________
                09:48  0.1      0.1      0.3         Ready     ____________
                09:58  0.0      0.0      0.2         Ready     ____________
                10:07  0.0      0.0      0.0         Ready     ____________
                10:16  0.0      0.0      0.0         Ready     ____________
                10:25  0.0      0.0      0.0         Ready     ____________
                10:35  0.0      0.0      0.0         Ready     ____________
                10:44  0.0      0.0      0.0         Ready     ____________
                10:53  0.0      0.0      0.0         Ready     ____________
                11:02  0.0      0.0      0.0         Ready     ____________
                11:12  0.0      0.0      0.0         Ready     ____________
                11:21  0.0      0.0      0.0         Ready     ____________
                11:30  0.0      0.0      0.0         Ready     ____________
                11:39  0.0      0.0      0.0         Ready     ____________
                11:49  0.0      1.2      8.9         Ready     ____________
                11:56  0.0     88.9     1530    008  Alarm     ____________
                12:05  0.0      0.2      0.5         Ready     ____________
                12:14  0.0      0.2      0.5         Ready     ____________
                12:23  0.0      0.0      0.3         Ready     ____________
                12:33  0.0      0.0      0.3         Ready     ____________
                12:42  0.0      0.1      0.3         Ready     ____________
                12:51  0.0      0.0      0.1         Ready     ____________
                13:00  0.0      0.0      0.3         Ready     ____________
                13:10  0.0      0.0      0.1         Ready     ____________
                13:19  0.0      0.0      0.0         Ready     ____________
                13:28  0.0      4.8     83.5         Ready     ____________
                13:37  0.0      0.1     13.6         Ready     ____________
                13:47  0.0      0.0      0.8         Ready     ____________
                13:56  0.0      0.0      0.1         Ready     ____________
                14:05  0.0      0.1     20.4         Ready     ____________
                14:14  0.0      0.3     18.3         Ready     ____________
```

Figure 3 Printed Output

length of the interval are printed at the top of the page. In Figure 3 there are 37 readings in an interval and the interval is 555 seconds long.

b. The interval start time. The first interval in Figure 3 begins at 14:59.

c. The lowest Event number in the interval, only if the Event number has changed.

d. The highest priority instrument status of the interval.

e. Space for the user to add Notes to the report. Notes could include identification of particular samples or sampling location based on Event numbers.

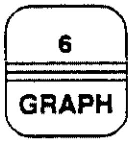
If "Output all data" is selected the header, containing the title, averaging interval and column headings, will only be printed on the first page of the printed output. Each of the following pages will contain 66 lines of data.

```
Printing now
  please wait...
```

To print all 12 hours of recorded data will require about 45 pages and take about 10 minutes. The actual printing time will depend on the printer and print quality. While the information is being printed, the display shows that printing is in progress. The keypad will not accept commands until the present print job has been completed.

Pressing EXIT during printing stops the job and the display reverts to normal. The printer will continue to print until its buffer is empty.

2.16 GRAPH



Pressing the GRAPH key also prints the recorded data but in graphical format. See Figure 4.

To graph recorded data:

```
Range 0-? ppm ↑↓
200
```

1. Press SETUP to set the range for the graph. Use the arrow keys to select the 20, 200 or 2000 ppm range.

2. Use the printer cable and suitable adapter (Photovac Part No. 395006) to connect the MicroTIP I/O connector to the printer.

```
ENTER to Graph
   * for Options
```

3. Press the GRAPH key and then the SETUP (*) key to select the desired setup options.

```
Start at Event?
      1
```

```
Stop with Event?
      24
```

4. MicroTIP will ask for the number of the start and stop Events. Enter the desired values and press ENTER.

5. Select which values are to be graphed. Use the arrow keys to select from:

```
Min Avg Max ? ↑↓
Avg
```

a. Min
b. Avg
c. Max
d. Min & Avg
e. Min & Max
f. Avg & Max
g. Min & Avg & Max

```
Output format? ↑↓
 Fit on one page
```

```
Output format? ↑↓
 Output all data
```

6. MicroTIP will then ask if the selected data are to be formatted to fit on a single $8^{1}/_{2}$" x 11" page or if all recorded data between the selected start and stop Events are to be graphed. Use the arrow keys to select the desired option and press ENTER.

```
ID number?
25008
```

7. Enter an ID number if desired. Any number up to 16 digits long may be entered as an ID number. The ID number can be used to differentiate between users or instruments. If more than one user is using a single instrument, each user will use an individual number for printed reports. If more than one MicroTIP is being used, each instrument can have its own ID number on printed reports.

   If an ID number is not required, leave this option blank and move onto the next option by pressing ENTER.

```
Baud rate ?    ↑↓
9600
```

```
Parity?        ↑↓
None
```

8. Enter the baud rate and parity. These values are specific to the printer being used and must be set correctly. Again, refer to the printer user's manual to determine the correct baud rate and parity.

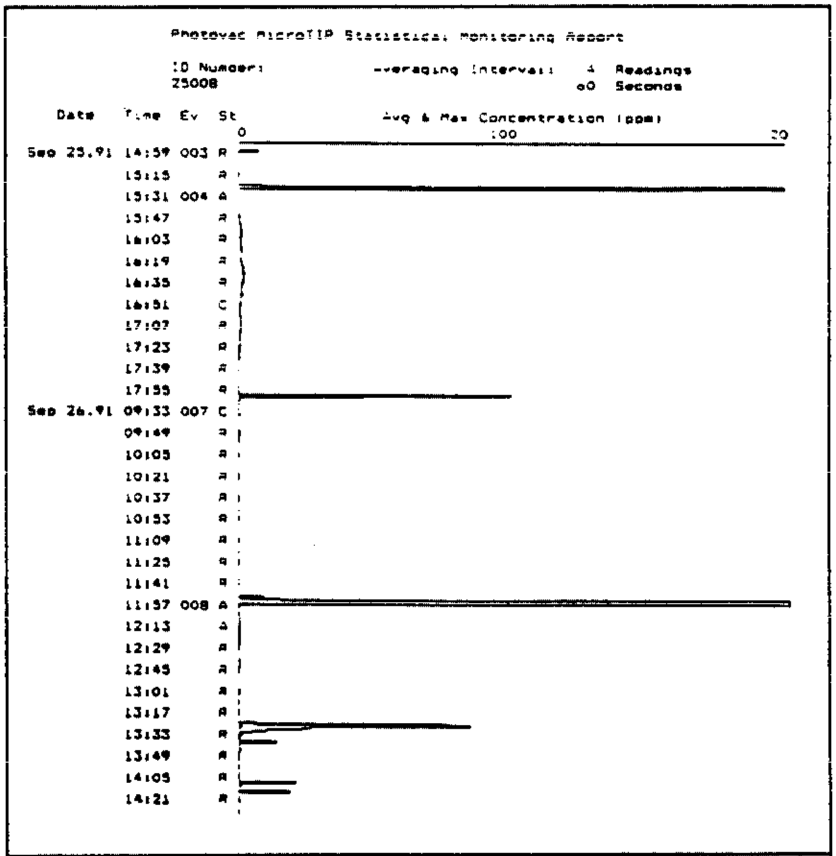
9. When the setup is correct, ensure the printer is on line and press ENTER.

If "Fit on one page" is selected, MicroTIP will divide the selected data into 600 averaging intervals. Sixteen intervals are graphed on each line.

MicroTIP always stores one set of readings (Min, Avg and Max) each 15 seconds. In each averaging interval the graphed mininum is the minimum of all the stored readings in that interval. The graphed Avg is the average of all the recorded average readings and the Max is the maximum of all the recorded maximum readings. The following information is printed:

a. The number of readings in an interval and the length of the interval are printed at the top of the page. In Figure 4 there is 1 reading in an interval and the interval is 15 seconds long.

b. Time is printed once every 16 intervals or every 16 minutes for the example in Figure 4. This time will be the start time of the next 16 intervals.



```
                  Photovac MicroTIP Statistical Monitoring Report

                  ID Number:              Averaging Interval:   4  Readings
                  25008                                        60  Seconds

     Date      Time  Ev  St              Avg & Max Concentration (ppm)
                            0                    100                       20
Sep 25.91 14:59 003 R
          15:15     A
          15:31 004 A
          15:47     A
          16:03     A
          16:19     A
          16:35     A
          16:51     C
          17:07     A
          17:23     A
          17:39     A
          17:55     A
Sep 26.91 09:33 007 C
          09:49     A
          10:05     A
          10:21     A
          10:37     A
          10:53     A
          11:09     A
          11:25     A
          11:41     A
          11:57 008 A
          12:13     A
          12:29     A
          12:45     A
          13:01     A
          13:17     A
          13:33     A
          13:49     A
          14:05     A
          14:21     A
```

Figure 4 Graphed Output

c. The lowest Event number of the 16 intervals is printed, only if it has changed from the previous set of 16 intervals.

d. The highest priority instrument status code of the 16 intervals is printed.

If "Output all data" is selected the header, containing the title, averaging interval and column headings, will only be printed on the first page of the graphed output.

To graph all 12 hours of recorded data will require about 4 pages and take about 10 minutes. The actual printing time will depend on the printer and print quality.

```
Printing now
  please wait...
```

While the information is being printed, the display shows that printing is in progress. The keypad will not accept commands until the present print job has been completed.

Pressing EXIT during printing stops the job and the display reverts to normal. The printer will continue to print until its buffer is empty.

2.17 HIGH SENSITIVITY OPERATION

MicroTIP can be used as a high sensitivity leak detector. In High Sensitivity operation, MicroTIP does not read directly in ppm but displays a reading proportional to the total concentration of ionizable gases and vapors detected.

During calibration, no span gas is required. MicroTIP zeros its reading with zero air and then sets itself to the maximum sensitivity.

```
Range 0-? ppm ↑↓
200
```

1. Press SETUP. Select the 0-20 ppm display range with the arrow keys and press ENTER.

```
Cal memory ?  ↑↓
High Sensitivity
```

2. Select High Sensitivity with the arrow keys and press ENTER.

```
HO █████      20
244 11:15 Feb 15
```

3. Press EXIT. Select the bar graph with the DISPLAY key.
4. Press CAL and calibrate MicroTIP with zero air. High Sensitivity operation does not require span gas.

```
Audio output? ↑↓
Continuous Audio
```

5. Press AUDIO and select "Continuous Audio" with the arrow keys.

As MicroTIP samples air closer to the leak, the length of the shaded area on the display increases. When used with the optional headset (Photovac Part No. 395030), the frequency of the tone increases as air closer to the leak is sampled, and the user need not watch the display.

MicroTIP's 3 second response time and detection limit of 0.1 ppm isobutylene permit fast detection of small leaks.

2.18 RESPONSE FACTORS FOR GASES AND VAPORS

In situations where only a single pure compound is present in air, MicroTIP should be calibrated with a standard of that specific compound as span gas. MicroTIP's 10 Cal Memories can be used to store calibration information for 10 different span gases.

MicroTIP's reading will always be influenced by any other photoionizable compounds present in the air sample. Even if MicroTIP has been calibrated with a specific compound, its response is not specific and the presence of another impurity may render the numerical result invalid.

It is often impractical to carry a range of different standards into the field. Approximate results can be obtained by calibrating MicroTIP with the recommended span gas and entering the appropriate response factor. The response factor is based on the ratio of the response of the specific compound to the response of the span gas. The response factor multiplies MicroTIP's reading then displays and records it (if the datalogger is on).

Table 2 gives response factors from which approximations can be made for guidance purposes. Data extrapolated from the use of response factors must be regarded as interim and approximate only. Table 2 should be used only for concentrations up to 100 ppm of the specific compound, because response factors change with concentration.

To use the data in Table 2:

1. Press the CAL key and enter the response factor for the specific compound.

2. Calibrate MicroTIP with zero air and 100 ppm span gas as described in Section 2.14.

3. Expose MicroTIP to the sample. The displayed reading is the approximate concentration of the specific compound.

Compound	Response Factor
Acetone	
Benzene	
Butyl Acetate	
Cyclohexane	
Cyclohexanone	
1,2-Dichlorobenzene	
Ethyl Acrylate	
n-Heptane	
Methyl Ethyl Ketone	
Methyl Isobutyl Ketone	
Methyl Methacrylate	
n-Octane	
Perchloroethylene	
Styrene	
Toluene	
Trichloroethylene	

Table 2 Response Factors

Note: These response factors serve as a guide to concentrations measured by MicroTIP with a 10.6 eV lamp. Results are expected to be accurate to within +/-10ppm or +/-25% of result, whichever is greater. Accuracy of response factors to other gases and vapors may differ from that stated.

These responses are measured relative to isobutylene span gas.

Chapter 3 Accessories and Other Devices

3.1 PRINTER

MicroTIP is designed to interface with an Epson FX-80 or 100% compatible printer with an RS232 serial interface. The printer cable (Photovac Part No. 395006) has been configured for this application only. If the printer being used is compatible with the Epson FX-80, then a suitable cable may be required or the existing one may require modifications. If you are unsure of the compatibility of the printer refer to the printer user's manual or contact the printer manufacturer.

In order to modify the existing printer cable the pinout information for the printer connector is required. Refer to the printer user's manual for specific details. The pinouts for the MicroTIP printer cable are shown in Figure 5 and are listed in Table 3. If modifying the cable is not possible, take the electrical and pinout information to a computer store where a suitable adapter may be obtained.

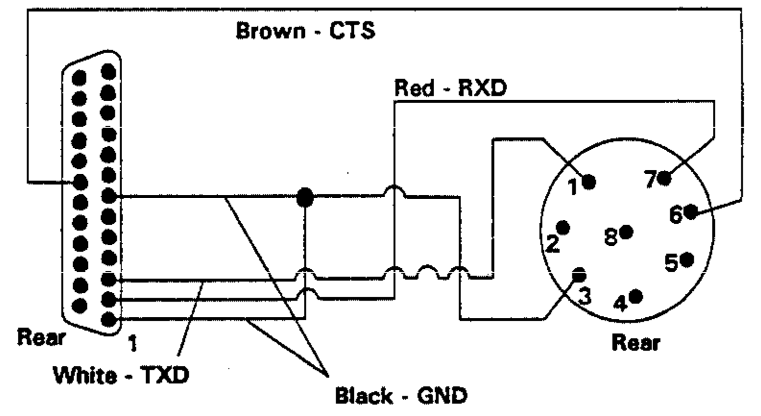


Figure 5 Printer Cable Electrical Connection

Once the proper cable has been obtained, ensure the printer is set to 8 data bits and 1 stop bit for communication and that the appropriate baud rate and parity have been selected. Use the PRINT and GRAPH keys as detailed in Sections 2-15 and 2-16.

MicroTIP I/O Conn. (8 pin) Pin #	MicroTIP Printer Cable (DB25) Pin #	Standard RS-232	Color
1	3	TXD	White
2	--	--	--
3	1 & 7	GND	Black
4	--	--	--
5	--	--	--
6	20	CTS	Brown
7	2	RXD	Red
8	--	--	--

Table 3 Printer Cable Pinouts

3.2 COMPUTER

MicroTIP will send information stored in its datalogger to a computer. The computer must be set up to emulate a terminal. The use of Crosstalk®, a communications software package, is recommended.

MicroTIP is set to 8 data bits and 1 stop bit for communication. The appropriate baud rate and parity must be selected. Use the PRINT key as detailed in Section 2-15.

Use the printer cable and a suitable adapter (Photovac Part No. 395006) to connect MicroTIP to the computer's serial port. The serial port may be labelled Com1 or Com 2. Refer to the computer user's manual to determine the baud rate and parity as these values will depend on the computer.

The baud rate can be set from 300 to 19200. The parity can be set to Odd, Even or None and again will depend on the computer. The port number will be the computer port to which MicroTIP is connected. Stop Bits must be set to 1. Correspondingly, Data Bits must be set to 8.

The following instructions are for Crosstalk Mark IV Version 2.0. The commands may vary depending on which version of Crosstalk is being used.

To initiate communications between MicroTIP and the computer:

1. Start Crosstalk. From the dialing directory select DIRECT and press Alt-S. A dialing directory entry will be created for communications with MicroTIP.

2. Enter the name of the dialing directory entry. Type in MicroTIP as the name.

3. Leave the Description as Direct <hardwired> connection.

4. Leave the Number option blank as there is no telephone number to be dialed.

5. Press the spacebar to turn the Capture option on. This option will store the data received from MicroTIP to the specified download directory.

6. Type in the Download Directory. This is the disk drive and directory on the computer to which MicroTIP data will be stored.

7. The Device should be selected as Modem even though a modem is not being used.

8. Enter the Computer Port to which MicroTIP has been connected. The port number will depend on how Crosstalk was configured when it was installed. Ensure MicroTIP has been connected to a serial port. See Section 5.3. MicroTIP will not work with a parallel port.

9. Set the desired speed. Ensure it matches the baud rate set on MicroTIP.

10 Set the WordFormat. Stop Bits must be set to 1, and Data Bits to 8. Parity may be set to odd, even or none depending on the computer.

11. Press Crtl-Enter to save the dialing directory entry. This entry may be saved with Crosstalk. Whenever Crosstalk is run, the MicroTIP entry will appear in the dialing directory. If nothing has changed this entry

may be used every time MicroTIP is connected to the computer. This will save the user having to set up Crosstalk each time.

12. Ensure the MicroTIP entry is selected in the dialing directory and press Enter.

13. Ensure the MicroTIP print setup matches that entered in the Crosstalk dialing directory and then press the MicroTIP PRINT key. The data will now appear in the Crosstalk communications window. It will be stored as it appears on the screen.

14. When all the data has been sent press Alt-C and turn the capture option off and then press Enter.

15. Press Alt-O to end the communications session.

The captured file will have an extension that corresponds to the current date. Convert this file to a text file using the MS-DOS® Copy Command:

16. At the DOS prompt type:
    Copy MICROTIP.814 MICROTIP.txt

17 The newly created file MICROTIP.txt can now be imported into Lotus 1-2-3 as a text file. See the Lotus 1-2-3 User's Manual for details.

3.3 CHART RECORDER

MicroTIP's output can be displayed as a 0 to 1 volt analog voltage on a chart recorder in real time. Set the chart recorder to 1V full scale and connect it to MicroTIP's I/O connector using the analog output cable (Photovac Part No. 395005). The concentration range of the analog output signal is selected with the SETUP key, and can be set to 20, 200, or 2000 ppm full scale.

3.4 SAMPLE BAG

MicroTIP is equipped with a sample outlet fitting (See Figure 1) from which samples may be collected for further analysis. Connect a sample bag to the fitting with a short length of 1/8" inside diameter flexible tubing.

Note: Readings may fluctuate due to changes in detector flow rate as the sample bag is filling.

The bag contents will not perfectly represent the sample. Ozone produced by MicroTIP's detector will be present, and sample composition may have been altered by passage through MicroTIP's sampling pump.

3.5 THREE METER (9.8') SAMPLE LINE

For remote sampling, connect the 3m (9.8') sample line (Photovac Part No. 390006) to MicroTIP's sample inlet in place of the 17cm (6.8") sample line supplied.

3.6 SHOULDER STRAP

Snap one end of the shoulder strap to the steel shoulder strap connector bail above MicroTIP's I/O connector. Snap the other end to one of the shoulder strap connectors beside the display. The connection point is selectable for right or left handed operation. Adjust the shoulder pad and strap length for comfort.

3.7 HEADSET

To connect the headset:

1. Remove the dust cap.
2. Connect the headset (Photovac Part No. 395030) to the I/O port and tighten the locking nut.
3. Use the knob on the headset to adjust the volume.

Operation of the headset is described in Section 2.11-2.13.

3.8 REPLACEMENT DETECTOR LAMPS

MicroTIP is supplied with an ultraviolet (UV) lamp which produces an energy of 10.6 electron-volts (eV). With this standard lamp installed, MicroTIP responds well to gases and vapors which ionize at 10.6 eV or less. Some of these are listed, with their response factors, in Table 2. For special applications, MicroTIP's response can be changed by using other lamps.

With a 9.5 eV lamp, MicroTIP responds well only to gases and vapors which ionize at 9.5 eV or less. Some response factors with a 9.5 eV lamp are listed in Table 4. To use the 9.5 eV lamp, MicroTIP must be calibrated with a compound which ionizes at below 9.5 eV. Toluene at 100 ppm in air is recommended.

Table 4 gives response factors from which approximations can be made for guidance purposes. Data extrapolated from the use of response factors must be regarded as interim and approximate only. Table 4 should be used only for concentrations up to 100 ppm of the specific compound, as response factors change with concentration. Data from Table 4 may be used in the same way as those from Table 2 if a single pure compound in air is being sampled.

1. Press the CAL key and enter the response factor for the specific compound.

2. Calibrate MicroTIP with zero air and 100 ppm span gas as described in Section 2.14.

3. Expose MicroTIP to the sample. The displayed reading is the approximate concentration of the specific compound.

In a situation where a range of gases and vapors exists, MicroTIP displays a reading representing the total concentration of photoionizable compounds present. The change in the response factor given by the 9.5 eV lamp is especially useful when sampling mixtures, for example, a mixture of benzene and n-octane. Both compounds are detected with MicroTIP, and benzene is the more toxic of the two. For health protection, a relatively higher response to benzene and a lower response to n-octane are desired in order to detect lower concentrations of benzene in the presence of n-octane.

COMPOUND	RESPONSE FACTOR
Acetone	
Benzene	
Butyl Acetate	
Cyclohexane	
Cyclohexanone	
1,2-Dichlorobenzene	
Ethyl Acrylate	
n-Heptane	
Methyl Ethyl Ketone	
Methyl Isobutyl Ketone	
Methyl Methacrylate	
n-Octane	
Perchloroethylene	
Styrene	
Toluene	
Trichloroethylene	

Table 4 Response Factors with 9.5 eV Lamp

Note: These response factors serve as a guide to concentrations measured by MicroTIP with a 9.5 eV lamp. Results for compounds with response factors of 3.3 and below are expected to be accurate to within +/- 10ppm or +/-25% of result, whichever is greater. Results for compounds with response factors above 3.3 are expected to be accurate to within +/- 40% of result. Accuracy of response factors for other gases and vapors may differ from that stated.

These responses are measured relative to toluene span gas.

The response factors in Tables 2 and 4 are inversely proportional to MicroTIP's response to a specific chemical, that is, a low response factor means that MicroTIP has a high response.

With a 10.6 eV lamp, the response factor of benzene is 0.6 and that of n-octane is 2.6 (from Table 2).

10.6 eV response ratio (benzene/n/octane) from Table 2:

$$= \frac{1/0.6}{1/2.6}$$

$$= 4.3$$

9.5 eV lamp the response ratio (benzene/n-octane) from Table 5:

$$= \frac{1/1.2}{1/10}$$

$$= 8.3$$

The response ratio for the 9.5 eV lamp is about twice that for the 10.6 eV lamp. Because of this difference in response, benzene vapor from the mixture contributes more to the MicroTIP reading with the 9.5 eV lamp than it does with the 10.6 eV lamp. MicroTIP with the 9.5 eV lamp is therefore better suited to detecting benzene in the presence of n-octane.

Pull nitrogen through µTip when not in use.

The 9.5 eV lamp is installed, maintained, and removed according to the instructions in Section 4.2.

With an 11.7 eV lamp installed, MicroTIP functions as a leak detector responding to gases and vapors which ionize at 11.7 eV or less. This lamp is intended for High Sensitivity operation only. It is not suitable for direct-reading use, because of limitations of the lamp window material.

The 11.7 eV lamp window material is Lithium Fluoride (LiF). Unlike other lamp windows, LiF readily absorbs water from atmospheric humidity. When contaminated by moisture, the window loses its ability to transmit UV light.

Note: Never touch the window or let liquid water near it.

Furthermore, LiF is composed of two light elements which are easily disrupted within the crystal lattice by the same UV light generated by the lamp. Disruption of the lattice causes the crystal to turn a yellowish color, and again performance declines.

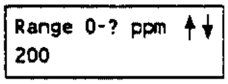
The 11.7 eV lamp is useful for detecting leaks of chemicals not ionized by the 10.6 eV lamp.

Carbon tetrachloride can be used as an example. Set MicroTIP to display a bar graph. The length of the shaded area on the display represents the concentration of carbon tetrachloride (and other ionizables) in the sample. As MicroTIP samples air closer to the carbon tetrachloride source, the display indicates higher concentrations.

Numerical values shown on MicroTIP's display should not be interpreted as parts per million concentrations. They indicate only the relative presence or absence of ionizable gases and vapors. MicroTIP's 3 second response time and detection limit of 10 ppm carbon tetrachloride permit fast determination of small leaks.

Because of the lamp window limitations, the lifetime of the 11.7 eV lamp is restricted and it must be used sparingly according to these instructions:

1. Remove the 11.7 eV lamp from the supplied dessicant bottle and install the lamp according to Section 4.2.
2. Switch on MicroTIP, wait for it to warm up, and press SETUP.



```
Range 0-? ppm ↑↓
200
```

3. Select the 0-20 ppm range with the arrow keys and press ENTER.

```
Cal memory ?  ↑↓
High Sensitivity
```

4. Select High Sensitivity with the arrow keys and press ENTER.

```
H0 ▇▇▇▇▇      20
244 11:15 Feb 15
```

5. Press EXIT and then select the bar graph with the DISPLAY key.

```
Connect zero gas
then press ENTER
```

6. Press CAL and calibrate MicroTIP with zero air. High Sensitivity operation does not require a response factor or span gas.
7. Every 15 minutes of operation, recalibrate MicroTIP with zero air.
8. Every hour of operation, switch off MicroTIP and examine the lamp window for yellowing. If the window is yellow, then remove the lamp and regenerate the window according to the procedure below.

9. After use, remove the lamp from MicroTIP and store it in the supplied dessicant bottle.

To regenerate the 11.7 eV lamp window:

1. Clean the lamp window with dry cerium oxide powder on a dry cotton swab. Do not use methanol or water.
2. Heat the lamp in a 150°C (300°F) oven for 8 hours or more.
3. Allow the lamp to cool before use.
4. Alternatively, the lamp window can be regenerated without heat by storing the lamp in a dessicator for at least 5 days.

Chapter 4 Routine Maintenance

4.1 CHARGING THE BATTERY

```
LoBat      100 ppm
250 14:20   Feb 15
```

When the instrument status reads LoBat, the MicroTIP battery pack requires recharging. A fully charged battery powers MicroTIP for 6 hours. If the instrument is to be used for more than 6 hours, carry a spare battery pack. When the first one has been discharged, replace it with the spare. Upon return from field work, recharge both battery packs as outlined in Section 1.2. Two chargers are required to do this overnight. Use only the MP-1000 battery charger (Photovac Part No. 395016/17).

The charger automatically charges at a high charge rate until the battery is fully charged and then maintains the full charge with a low continuous charge rate indefinitely so there is no danger of over-charging.

Note: Leaving MicroTIP for more than three days without a charged battery pack will result in loss of recorded data and setup parameters. To avoid loss of data, charge the battery pack for at least 8 hours and put it back onto the instrument.

If MicroTIP is not used regularly, the battery should be charged at least twice a year for at least 8 hours, but not more than 72 hours.

4.2 CLEANING THE LAMP WINDOW

During the course of normal operation a film builds up on the window of the detector lamp. The rate at which the film develops depends on the type and concentration of the gases and vapors being sampled and results from the UV light interacting with them. As a guide, clean the window every 24 hours of operation.

1. Ensure the instrument is turned off.

2. Hold the black detector housing in one hand and unscrew it from the body of MicroTIP. Remove the housing, being careful not to lose the o-ring seal on top of the photoionization detector. The detector

cell, lampholder, and high frequency (HF) driver circuit board are now exposed.

3. Unplug the red and yellow wires from the HF driver circuit board.

4. Locate the black ground wire. Loosen the screw on the oscillator board and disconnect the black wire.

5. Hold the lampholder in one hand so it will not rotate and carefully unscrew the detector cell with the red and yellow wires attached.

Note: Do not touch the fine wire mesh inside the detector cell. Any dust or dirt in the detector cell can be blown out with a gentle jet of compressed air.

6. Leaving the lamp spring in place, remove the lamp from the lampholder.

7. To remove the film, gently rub the window of the lamp with a lint free tissue moistened with methanol.

– not w/11.7 eV lamp!

8. Allow the window to dry and then, without touching the window, replace it in the lampholder.

9. Replace the detector cell squarely on the lampholder and ensure the o-ring seal is in position. Finger tighten only. Do not over-tighten.

10. Replace the black wire below the screw on the oscillator board and tighten the screw down. Plug the yellow wire onto the gold pin and the red wire onto the silver pin on the HF driver circuit board.

11. Check the lampholder and ensure it is securely seated by hand.

13. Replace the detector housing and tighten by hand.

Calibrate MicroTIP and then continue normal operation.

```
Fault      0.0 ppm
251 14:50  Feb 15
```

```
Detector light
 intensity is low
```

4.3 REPLACING THE DETECTOR UV LAMP

If the lamp has failed then it requires replacement:

1. Remove the lamp as outlined in Section 4.2.
2. Remove the lamp spring from the lampholder and replace it with the new lamp spring.
3. Without touching the window of the new lamp carefully place it in the lampholder.
4. Replace the detector cell and the detector housing as outlined in Section 4.2.

Once calibrated, MicroTIP is ready for operation.

4.4 REPLACING THE INLET FILTER

MicroTIP is equipped with a dust filter to reduce detector contamination. As the filter collects dust, MicroTIP's inlet flow rate and sensitivity decrease. Replace the filter every 240 hours of operation, or more frequently if MicroTIP is used in a dusty environment. Do not operate MicroTIP without an inlet filter.

1. Turn the instrument off. Hold the filter housing near the detector housing with a $^{9}/_{16}''$ wrench.
2. Unscrew the top of the filter housing with another $^{9}/_{16}''$ wrench. Be careful not to lose the metal sealing washer.
3. Remove the spring and filter and install the new filter, open end first. Replace the filter spring and the top of the filter housing. Tighten the top nut while holding the bottom one stationary with the wrench.
4. Once calibrated, MicroTIP is ready for operation.

4.5 REPLACING THE SAMPLE PUMP

Replace the sample pump after every 5000 hours of use.

1. Turn the instrument off and remove the battery pack.

2. Place MicroTIP upside down on a clean, flat surface and remove the 4 screws securing the handle to the control housing. Now remove the two screws in the handle flare.

3. Carefully lift the handle away from the control housing. The two parts remain connected by the wires from the I/O connector.

4. Locate the red sample pump mounted on the bottom of the power supply printed circuit board. See Figure 6.

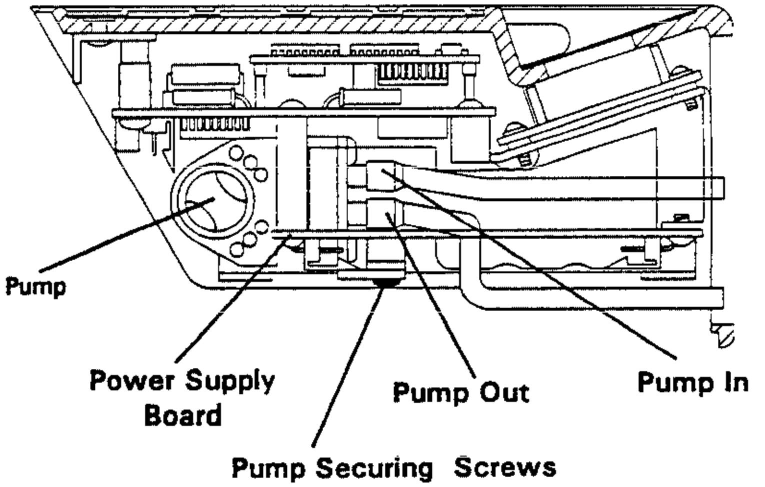


Figure 6 Pump Placement

5. Disconnect the 2-pin pump connector from the power supply board and then remove the 2 screws securing the pump to the power supply board.

6. Gently pull the pump out about 1/2" and remove the 2 pieces of clear tubing from the pump.

7. Connect the clear tubing to the new pump and slide the new pump into position.

8. Secure the new pump with the 2 screws.

9. Connect the 2-pin connector from the new pump to the socket on the power supply board.

10. Carefully position the handle over the control housing and replace the 6 screws in the bottom of the handle and in the handle flare.

11. Snap the battery pack into place. Turn the MicroTIP on and calibrate it.

Chapter 5 Troubleshooting

5.1 IF MICROTIP DRAWS IN LIQUID

MicroTIP accepts only gas and vapor samples. Aspirating a liquid may result in damage to the lamp and the pump. If water is drawn in, the affected parts of the instrument may be cleaned and dried. Contact Photovac Service if another liquid is aspirated.

1. Before taking the instrument apart allow MicroTIP to run until no more liquid comes out of the sample outlet fitting below the detector housing. This will clean out the pump.

2. Turn the instrument off. Remove the detector cell and lamp as outlined in Section 4.2.

3. Dry the lamp with a clean lint free tissue and clean the window. See Section 4.2.

4. Clean the detector cell in distilled water, preferably in an ultrasonic cleaner.

Note: **Do not** touch the fine wire mesh in the detector cell. **Do not** use solvents as they will degrade the detector cell.

5. Dry the detector cell overnight at 50°C (125°F).

6. Dry the inside of the lamp holder.

7. Remove the filter cartridge as in Section 4.4 and dry the inside of the filter housing.

8. Install a new filter (Photovac Part No. 395000) and re-assemble the filter housing.

Once calibrated, MicroTIP is ready for operation.

5.2 INSTRUMENT STATUS AND FAULT DISPLAYS

The instrument status appears at the left of the upper line of the display and on the Print and Graph outputs. Each status has a priority assigned to it. If more than one status is in effect, then the status with the highest priority is displayed until the condition is corrected or until the option is turned off.

Status	Code	Priority	Description
Fault	F	1	One of 3 faults is occurring. Press TUTOR for details.
Cal	C	2	Will never be observed on the display during normal operation as various calibration prompt messages are displayed while MicroTIP is calibrating. If the instrument is turned off when it is calibrating with span gas, Cal will appear on the display when MicroTIP is turned on again indicating the last calibration was incomplete. Cal status is also shown on printed and graphed output.
Over	O	3	Detected concentration exceeds 2000 on the display.
Alarm	A	4	Detected concentration exceeds the set alarm level.
LoBat	L	5	Battery pack power is low. Recharge or replace pack.
Play	P	6	The instrument is playing back previously recorded data.
HiSens	H	7	High Sensitivity operation.
Ready	R	8	Normal operation.

Table 5 Instrument Status

When the bar graph display or the Graph output is selected, the instrument status is reduced to a one-letter code. Table 5 summarizes the instrument status and priority.

When the Fault status is displayed, MicroTIP's operation is compromised. Press the TUTOR key for a two-line description of the fault.

MicroTIP must be serviced away from hazardous locations.

```
Detector light
 intensity is low
```

Fault: Detector light intensity is low

Cause: Defective detector or UV lamp.
Action: Replace the UV lamp. See Section 4.3.

Cause: Poor connection between lamp holder and HF driver circuit board.
Action: Check the green wire joining lamp holder to HF driver circuit board. Ensure it is securely connected to both the lampholder and the circuit board. See Section 4.2.

```
Signal from zero
gas is too high
```

Fault: Signal from zero gas is too high

Cause: Contamination of sample line or fittings before the detector.
Action: Clean or replace the sample line or the inlet filter. See Section 4.4.

Cause: Span and Zero gases mixed up.
Action: Ensure clean gas is used to zero MicroTIP and that the span gas is of a reliable concentration.

Cause: Contamination in the detector.
Action: Clean the detector. See Section 5.1.

Cause: Short circuit in the detector.
Action: Remove detector ensure resistance between red wire and yellow wire exceeds 10 megohms.

```
Detector field
 voltage is low
```

Fault: Detector field voltage is low

Cause: Internal fault electronics.
Action: Contact Photovac in Service.

5.3 ESTABLISHING COMPUTER COMMUNICATIONS

If, after having followed the procedure in Section 3.2, communications cannot be established with a computer, the problem may lie with the hardware connections or the printer cable configuration.

1. Ensure MicroTIP is connected to the serial port of the computer.

   The serial port will usually be a male connector, typically 9 pins on an IBM-AT® and compatibles and 25 pins on an IBM-XT® and compatibles. The 25 (or more) pin female connector is usually a parallel port. MicroTIP **cannot** be connected to a parallel port.

   An exception to this rule is Tandy® Computers, which use a female 25 pin connector for the serial port.

2. Ensure the cable being used is compatible with the device.

   An IBM-AT and compatibles with a 9 pin serial connector will first require a null modem to switch pins 2 and 3. Next a gender changer that converts the male DB25 connector on the printer cable from male 25 pins to female 9 pins is required. These two adapters have been combined into one, which is supplied with the MicroTIP printer cable.

   An IBM-XT and compatibles should not require a null modem but will require a gender changer. A gender changer will convert the male DB25 connector on the printer cable to a female connector. A gender changer is supplied with the MicroTIP printer cable.

   The pin definitions of interest are listed in Table 6. Only pins 2 and 3 are shown since these are the problem pins:

Pin #	MicroTIP	IBM-AT	IBM-XT
2	Rxd	Rxd	Txd
3	Txd	Txd	Rxd

Table 6 Pin Definition

Pins 2 and 3 should be **mismatched** between MicroTIP and the computer. Ensure this is the case. It is also possible that the cable being used may switch pins 2 and 3 even if it is not necessary. i.e. the cable is a null modem. IBM-XT cables are usually null modems, since a null modem is required for connection to a printer.

If you are using an IBM-AT and find that a null modem is not required it is possible that an IBM-XT serial port has been added to an expansion slot and thus does not require a null modem. The opposite may be the case if an IBM-AT serial port was added to an IBM-XT expansion slot, in which case the null modem is required.

3. Ensure all hardware is working properly.

Use a printer to test both MicroTIP and the computer. Connect MicroTIP to the printer and ensure that this arrangement produces the desired results. If correct printout is obtained then the MicroTIP and the printer cable are okay.

Now connect the computer to the printer and ensure this works. If the desired printout is obtained this ensures the computer is sending data correctly.

Chapter 6 Technical Description

6.1 OVERVIEW

MicroTIP is a microprocessor controlled instrument for measuring the presence of photoionizable chemicals in air at parts per million levels. The block diagram in Figure 7 shows the main components of MicroTIP. The microprocessor controls the components of the instrument and interprets and records the signal generated by the photoionization detector (PID). Recorded data and setup information entered into the microprocessor's memory are retained when MicroTIP is turned off.

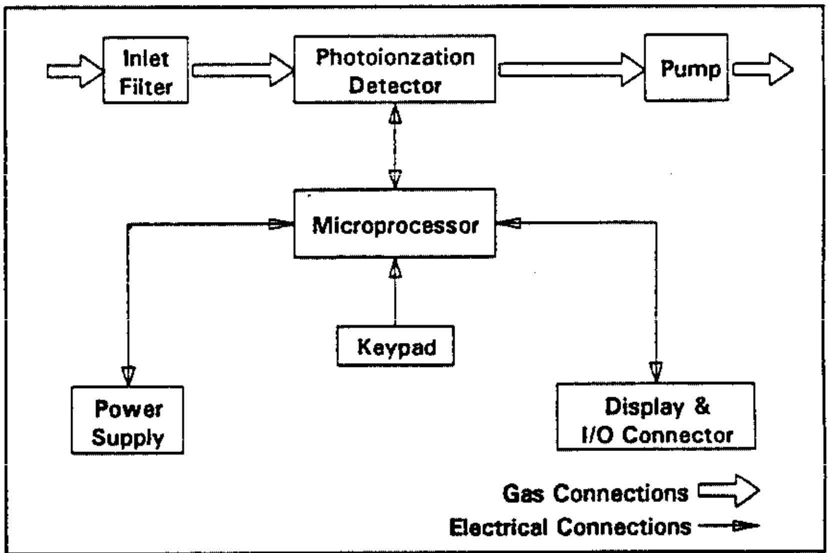


Figure 7 Block Diagram

A pump continuously pulls the air under test through MicroTIP's PID. The PID converts the concentration of ionizable chemicals in a sample into an electrical signal. The microprocessor subtracts any background from the signal and divides this signal by a sensitivity previously obtained by calibrating with a standard gas of known concentration. This concentration appears on MicroTIP's display and, depending on the values entered through MicroTIP's keypad, an alarm message may be displayed or an audio signal may be heard.

MicroTIP can detect thousands of different types of airborne gases and vapors and its response depends on the type as well as the concentration. MicroTIP does not distinguish one type of chemical from another, but displays a number indicating the total concentration of all ionizable compounds in the sample.

A standard of isobutylene at a known concentration may be used for setting the sensitivity. If MicroTIP is calibrated with isobutytlene, it displays concentrations in units equivalent to ppm of isobutylene. If isobutylene were the only ionizable chemical in the sample, then MicroTIP would display its concentration directly.

MicroTIP responds more or less readily to other chemicals than it does to isobutylene. Because it has a medium sensitivity to isobutylene, this gas has been chosen as a reliable means of reporting an average concentration of total ionizables present.

For special applications, gases other than isobutylene can be used to calibrate MicroTIP.

6.2 PHOTOIONIZATION DETECTOR

MicroTIP's PID is shown in Figure 8. The PID measures the concentration of ionizable chemicals in the gas stream from the sample inlet and produces an electrical signal for the microprocessor.

A UV lamp generates photons which ionize specific molecules in the gas stream. The permanent air gases (argon, carbon dioxide, nitrogen, oxygen, water vapor etc.) require a relatively high energy for ionization, and are not ionized by the UV photons. Many of the chemicals considered pollutants, including most hydrocarbons, are ionized.

The gas stream is directed into the PID through a small port at the center of the lamp window and through a series of larger ports around the perimeter of the lamp window. This bypass arrangement permits a high sample flowrate and short response time, while minimizing contamination of the lamp window.

The ionized molecules in the detector cell are subjected to a continuous electric field between the repeller electrode and

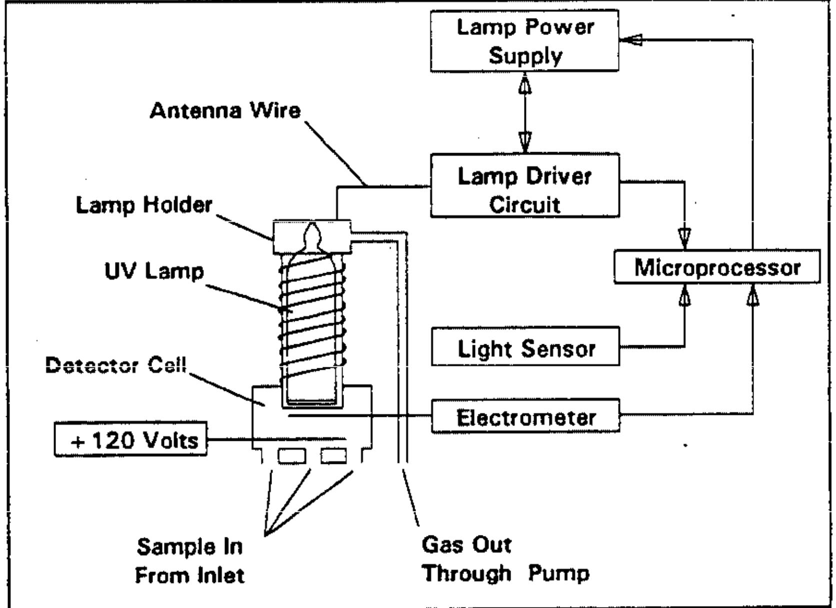


Figure 8 Photoionization Detector

the collector electrode. The ions move in the electric field, generating a current which is proportional to the concentration of the ionized molecules in the detector cell. An electrometer circuit converts the current to a voltage which is then fed to the microprocessor.

The detector lamp is operated by an HF lamp driver circuit which delivers high frequency energy to the lamp through an antenna wrapped around the lamp holder. The lamp driver power supply is controlled by the microprocessor based on a feedback signal from a light sensor on the HF driver circuit board.

6.3 CALIBRATION AND RECORDING

Periodic calibration is required to compensate for PID output changes due to inlet filter restriction, lamp window cleanliness, sample pump wear and other factors.

During calibration, MicroTIP's PID is first exposed to zero air. A small signal is generated. This zero signal is stored by the microprocessor.

In High Sensitivity operation, the microprocessor subtracts the zero signal from the PID signal, and multiplies the difference by 1000. This number is then displayed.

When one of the 10 Cal Memories is selected, MicroTIP's PID is next exposed to span gas. This span signal is stored. The microprocessor subtracts the zero signal from the span signal and divides the difference by the user-entered span gas concentration. The resulting sensitivity is stored in the selected Cal Memory with the zero signal. In operation, the microprocessor first subtracts the zero signal from the PID signal, then divides the difference by the sensitivity. This number is then multiplied by the response factor and displayed.

The microprocessor accumulates all readings over a 15 second interval and determines the minimum, average and maximum readings. It stores these numbers along with the highest priority instrument status and the most recent time, date and Event number which occurred during the 15 second interval. MicroTIP automatically records these results for 12 hours of operation when the datalogger is turned on.

These recorded data can now be played back on MicroTIP's display. The display is identical to the numeric or bar graph display, but the instrument status is "Play" indicating that recorded data, not real-time data, are being displayed. During playback MicroTIP continues to analyze and record new data.

Recorded data can also be printed as either a table or a graph. Data may be automatically averaged to fit on one 8½" x 11" page, or all recorded data may be printed or graphed. The averaging interval and number of readings averaged are shown at the top of the page.

For each averaging interval, MicroTIP prints the minimum of all the minima, the average of all the averages and the maximum of all the maxima.

Chapter 7 Specifications

Size:	43 cm (16.9") long, 9.5 cm (3.75") wide, 14.6 cm (5.75") high
Weight:	2.5 kg (5.5 lbs)
Detector:	Photoionization, bypass-type, with standard 10.6 eV HF-excited electrodeless discharge tube
Keypad:	16-key silicone with tactile feedback
Display:	2-line, 16-character dot-matrix, liquid crystal with adjustable backlighting, for alphanumeric and bar graph readouts
Datalogging memory:	25k
Chart recorder output:	0 to 1 volt full scale
Serial output:	RS-232, 300-19200 baud with odd, even or no parity, for tabular and graphic printouts
Audio output:	Continuous concentration-modulated tone or tone on alarm only
Inlet connection:	1/8" (3.2 mm) stainless steel compression fitting
Outlet connection:	1/8" (3.2 mm) stainless steel barb fitting
Battery type:	Sealed lead-acid, field-replaceable pack
Charge/discharge time:	8 hr/6 hr
Battery charger:	Automatically charges and maintains full charge in battery pack
Materials in sample stream:	Stainless steel, Teflon®, Viton®
Inlet filter:	Replaceable stainless steel, 2 um
Inlet flowrate:	Exceeds 500 mL/min

Operating temperature range:	0 to 40°C (32 to 105 °F)
Operating humidity range:	0 to 100% Relative Humidity (non-condensing)
Operating concentration range:	0.1 to 2000 ppm isobutylene equivalent
Accuracy:	Isobutylene: (after calibration with zero air and 100 ppm isobutylene span gas): within +/-2 ppm or +/-10% for 0 to 100 ppm; within +/-15% for 100 to 1000 ppm; within +/-20% for 1000 to 2000 ppm Acetone: (after calibration with zero air and 100 ppm acetone span gas): within +/-4 ppm or +/-10% for 0 to 100 ppm; within +/-15% for 100 to 1000 ppm; within +/-20% for 1000 to 2000 ppm Benzene: (after calibration with zero air and 100 ppm benzene span gas): within +/-4 ppm or +/-10% for 0 to 100 ppm; within +/-20% for 100 to 1000 ppm; within +/-25% for 1000 to 2000 ppm Toluene: (after calibration with zero air and 100 ppm toluene span gas): within +/-2 ppm or +/-10% for 0 to 100 ppm; within +/-20% for 100 to 1000 ppm; within +/-25% for 1000 to 2000 ppm Trichloroethylene: (after calibration with zero air and 100 ppm trichloroethylene span gas): within +/-5 ppm or +/-10% for 0 to 100 ppm; within +/-25% for 100 to 1000 ppm; within +/-35% for 1000 to 2000 ppm
Precision:	+/-1% (100 ppm isobutylene)
Response time:	Less than 3 seconds
Detection limit:	0.1 ppm isobutylene

Chapter 8 Warranty

MicroTIP is warranted for one year against defects in materials and workmanship.

Photovac Incorporated warrants that its manufactured products (except Detector UV Lamps which carry specific warranties) will be free from defects in materials and workmanship for a period of one (1) year from the date of receipt by the Customer. This Warranty applies to proper use of the equipment by the customer and may be voided if, in the opinion of Photovac Incorporated, the product has been abused or treated in a negligent manner so as to cause damage or failure. Negligent use includes, but is not limited to, exposure of the internal parts of the equipment to water. Damage caused thereby is expressly excluded from this Warranty.

When Photovac is made aware of a problem in MicroTIP which would be eligible for remedy under Warranty, it will issue a Return Authorization Number to the Customer. No return will be accepted unless such authorization has been obtained.

If upon receipt of the equipment Photovac determines that repairs should be done under Warranty, Photovac's sole liability shall be for labor and materials necessary to put the equipment into proper order and return this to the Customer as promptly as possible. Photovac is in no way responsible for any inconvenience or loss, consequential or incidental, caused to the Customer as a result of the equipment being out of commission.

The Customer is responsible for shipping and insurance to the designated Photovac Service/Repair facility.

In USA:
Photovac International Incorporated
25-B Jefryn Boulevard West
Deer Park, New York
11729
(516)254-4283

In Canada:
Photovac Incorporated

105 Doncaster Avenue
Thornhill, Ontario
L3T 1L6
(416)881-8225

Outside USA and Canada: Contact the Photovac representative in your area.

Appendices

APPENDIX A - INSTALLING AC PLUG

The MicroTIP battery charger is supplied with a grounded North American plug for 100-130 VAC operation. For use in other countries it must be replaced with a suitable plug.

1. Cut the power cord near North American style plug.
2. Separate and strip the two wires.
3. Connect one wire to the neutral terminal of the new plug. Connect the other wire to the live terminal of the new plug and assemble the new plug.
4. Set the voltage selection switch, on the bottom of the battery charger, to the correct voltage.

Warning: Incorrect AC connection can be lethal. Photovac cannot be responsible for errors in connection.

APPENDIX B - SPAN GAS SUPPLIER

The MicroTIP Calibration Kit includes the following items:

1. Gas pressure regulator with contents gauge, to fit a 6D size cylinder of span gas
2. Gas sampling bag
3. Adapter tubing with fittings for regulator and MicroTIP inlet (attached to gas bag).

The kit does not include a tank of span gas. The recommended span gas, isobutylene at 100ppm +/-5% in air, may be obtained from Alphagaz. In United States and Canada contact:

Non-returnable bottle:
800-248-1927

Alphagaz Specialty
Gases Division,
Liquid Air Corporation,
P. O. Box 149, Woods Road
Cambridge, MD 21613, USA

Tel: (800) 638-1197
(301) 228-6400

Canadian Liquid Air
Customer Service
6880 Lafontaine
Ville D'Anjou
Quebec, Canada
H1M 2T2
Tel: (514)351-7014

Outside the US and Canada, contact the US Alphagaz office above for the nearest location.

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APPENDIX C

Groundwater Sampling and Water Measurements

Appendix C

Contents

Appendix C, Part 1
GESOP 8
Groundwater Sampling

ENVIRONMENTAL RESTORATION DEPARTMENT

DOCUMENT APPROVAL COVER SHEET

INFORMATION ONLY

Document Number: SOP - 11.8

Revision: 0

Title: **ERD Standard Operating Procedure - Ground Water Sampling**

Prepared by: Karen N. Keck

Date: 3-9-92

Reviewed by: J.P. Shea by L.L. Jenkins

J. P. Shea, Chairman
ERD Independent Review Committee

Date: 3-9-92

Approved by: Lois C VanDeusen

L. C. VanDeusen, Manager
Site Remediation Group

Date: 3-26-92

Approved by: R Lee Norland

R. L. Norland, Manager
Buried Waste Program (WAG 7) Group

Date: 3-27-92

ENVIRONMENTAL STANDARD OPERATING PROCEDURES MANUAL	TITLE: **GROUND WATER SAMPLING**
	NUMBER: 11.8 ISSUE DATE: 03/09/92
APPROVED:______________________ Manager	

1.0 PURPOSE AND SCOPE

This procedure provides general instructions and requirements for the sampling of ground water. Ground water sampling entails collecting ground water for geochemical and contaminant chemistry analyses for ground water adjacent to the well screen. Often the investigator will be evaluating contaminants at the parts per million (ppm) or parts per billion (ppb) concentration levels. Consequently, the possibilities of errors in data collection are enlarged. Therefore, extreme care and quality control must be used when obtaining samples.

Implement this procedure in conjunction with the statement of work (SOW) for the analytical laboratory. The laboratory should be contacted through the ERD SMO prior to sampling to obtain the proper sample-handling specifications.

2.0 PROCEDURE

2.1 Quality Assurance

Activities conducted according to this procedure will be in compliance with an investigation-specific Quality Assurance Project Plan (QAPjP) or other project-level plan as applicable.

2.2 Health and Safety

Activities conducted according to this procedure will be in compliance with an investigation-specific Health and Safety Plan and/or Safe Work Permit, as required.

2.3 Training

All personnel training relative to the use of this procedure shall be conducted in compliance with Section 2.0 of QPP-149 (EG&G, 1991a) or other applicable EG&G QPPs at the direction of the Project Manager.

2.4 Field Equipment

A list of necessary and recommended equipment is included in Table 1. Sampling equipment will be decontaminated prior to use in the field and after use according to ERP-SOP-*11.5 Field Decontamination of Sampling Equipment*. Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces prior to insertion into the well. Non-dedicated pumps and tubing must be thoroughly decontaminated between well sampling sites.

2.5 Measurement of Static Water Level

Prior to bailing, purging and sampling of the well, the static water level in the well must be measured. Water levels are measured from the surveyed reference marker and recorded to the nearest 0.01 ft. Procedures for taking static water level measurements are outlined in ERP-SOP-11.9 *Measurement of Ground Water Levels*. Repeat the ground water level measurements again after sample collection.

2.6 Purging the Well

The water standing in a well prior to sampling may not be representative of in-situ ground-water quality. The standing water in the well and filter pack should be removed so that formation water replaces the stagnant water. When purging standing water in the casing, typically three to five times the calculated volume of water in the well is removed in an effort to obtain a representative sample from the aquifer. The actual number of volumes to be removed are specified in the Sampling and Analysis Plan (SAP). To calculate the volume of standing water in a well, the following generalized equation may be used:

$$V = (h_1 - h_2)r^2(0.163)$$

where: V = static well volume in gallons
h_1 = depth of the well in feet, from the top of the casing
h_2 = depth to water, in feet, from the top of the casing
r^2 = inside radius of well casing in inches

Well purging continues until the volume specified in the SAP is removed and certain indicator parameters (i.e., pH, specific conductance, dissolved oxygen and temperature) are stabilized. Take measurements periodically during purging and again after sample collection to check the stability of the water sampled over time. Stabilization of the indicator parameters is satisfied when successive readings indicate the following criteria are met:

a. pH: ± 0.1 standard units

b. Specific conductance: ± 10 micromhos/cm

c. Temperature: ± 0.5° C

d. Dissolved oxygen: ± 1 mg/L

Document the readings of the indicator parameters on the well purging field measurements data sheet (Figure 1). After purging the well, record the amount of water removed on the data sheet.

2.7 Low-Yield Formations

When purging a low-yield well (a well that is incapable of yielding three casing volumes), evacuate the well to dryness once. As soon as the well recovers sufficiently (ample water for collection), the first sample should be tested for pH, specific conductance, dissolved oxygen and temperature. Samples should then be collected and containerized in the order of the parameters' volatilization sensitivity. In the event the well has very limited production it may be possible to collect smaller volumes depending on the analysis required and after consultation with the analytical laboratory and ERD SMO. Retest the well after the samples have been collected for pH, specific conductance, dissolved oxygen, and temperature as a measure of purging efficiency and as a check on the stability of the water samples over time.

2.8 Disposal of Purge Water

Refer to the site specific SAP and Investigation Derived Waste Plan for the proper handling of purge water.

2.9 Selecting Equipment for Collecting the Water Sample

Select sampling equipment so that disturbance of the actual concentrations of the chemical constituents of interest is minimized. To remove water from the well, bailers, low-volume suction pumps, and submersible pumps may be used. Use of dedicated bailers or pumps for each well is desirable, where feasible, to avoid cross contamination.

2.9.1 Dedicated Pumps

Many of the production wells at the INEL have dedicated high capacity turbine pumps. The advantage of having dedicated pumps at a well include: avoiding cross-contamination between wells, water samples are readily available, and provides an efficient manner for sample collection. However, the high flowrates may impact the volatiles present in the water due to the agitation of the water.

2.9.2 Bailer

A bottom-filling bailer constructed of Teflon™, or stainless steel can be used to remove the stagnant water in monitoring wells and obtain samples. The bailer is preferred when volatile stripping is of concern or the well casing diameter is too narrow to accept a submersible pump. However, this method can be very time-consuming and is recommended for shallow wells only. The bailer should not come in contact with any materials outside of the well casing. Wear clean disposable gloves during sampling and changed between each well sampling. Keep the bailer cord (teflon coated) clean and change the cord after each well sampling. Sample from 5 to 10 feet below water level or as the SAP specifies. Lower the bailer slowly until it contacts the water surface and allow the bailer to sink and fill with a minimum of surface disturbance. Slowly raise the bailer to the surface. Tip the bailer to allow slow discharge from the top of the bailer to the sample bottle, allowing the water sample to flow gently down the side of the sample bottle with minimum entry disturbance.

2.9.3 Electric Submersible Pumps

Submersible pumps are used for both the purging and collection of samples from depths which often exceed the limitations of conventional sampling equipment and can be used to sample several monitoring wells in a brief period of time. Before lowering into the well, the discharge tubing is rolled out and cleaned using a cloth and non-phosphate detergent followed by a rinse with distilled water. Then the pump is slowly lowered into the well with the safety line. All tubing and cord is gently wiped clean with cloth as the pump is lowered. Ideally the pump is set just below the dynamic water level and above the screened section of the well. The pump should not be set on the bottom.

2.9.4 Positive Displacement Pumps

Positive displacement pumps work by blowing compressed air or an inert gas into a sample chamber. The gas displaces the water in the chamber and forces it up an excavation tube. The gas is blown intermittently, using a pressure-controlled regulator, to allow for recovery. Water returns to the sample chamber from the well through the bottom of the sampler, and is then prevented from leaving the bottom by a ball check-valve. Although the sampler is in contact with compressed air or inert gas, there is no violent introduction of gas into the sample, so the sample water is unaltered. All downhole parts must be assembled and cleaned with a non-phosphate detergent and rinsed before use in each well.

2.9.5 Air-lift Pumps

Air-lift pumps are useful for evacuation of the well or as skimmers, separating liquid from solid, but not for sampling. The violent introduction of air into the water changes its chemical characteristics. These pumps may be used when samples are to be analyzed for constituents that are not volatile, are not effected by aeration, and are not effected by changes in pH.

2.9.6 Lysimeters

Lysimeters are used for sampling water in the unsaturated zone. They induce the collection of soil moisture through negative pressure. A vacuum is put on the chamber, which is buried in the unsaturated zone, and moisture is drawn into the sample chamber through a porous-filter intake. Depending on soil texture and moisture content, as much as several hours or days under vacuum may be required.

2.10 Filling the Containers

Inspect the containers first to ensure they are the right type and number and are certifiably pre-cleaned. Wear clean gloves to prevent skin oils, dust particles or other contaminants from contaminating the sample. Gloves may also serve to protect the sampler from direct skin contact with the sample material, when potential contaminants are present. Affix the waterproof gummed labels containing information concerning the sample ID number, name of project area/well, type of analysis, date, and time to the containers at the time of collection. Place clear plastic tape over the label to protect it from damage. Transfer samples in the field from the sampling equipment directly into the container that is specifically prepared for that analysis. It is not an acceptable practice for samples to be composited in a common container in the field and then split in the laboratory, or poured first into a wide mouth container and then transferred into smaller containers. Pour the samples carefully into the containers, avoiding agitation or turbulence, which might result in loss of volatile organics and/or excessive oxygenation of the samples. Fill the bottles to the neck, except for volatiles, which require no headspace to minimize the possibility of volatilization of organics. Be careful to avoid breakage and to eliminate the entry of, or contact with, any substance other than the water sample being collected. Do not remove caps until the actual sampling time and then just long enough to fill the container.

Samples should be collected and containerized in the order of the volatilization sensitivity of the parameters of interest. A preferred collection for some common ground-water parameters is as follows:

a. Volatile organics (VOA)

b. Purgeable organic carbon (POC)

c. Purgeable organic halogens (POX)

d. Total organic halogens (TOX)

e. Total organic carbon (TOC)

f. Extractable organics

g. Total metals

h. Dissolved metals

i. Phenols

j. Cyanide

k. Sulfate and chloride

l. Turbidity

m. Nitrate and ammonia

n. Radionuclides

2.11 Filtration

Prior to preservation, water samples for dissolved metals analysis are filtered through a 0.45 micron pore-size filter to remove suspended particulate matter. Some radionuclides require filtration except certain radionuclides (i.e., tritium, carbon 14, and radioiodines). Usually the majority of radioactivity is in the solid phase and dissolved isotopes have an affinity for adsorption on solid particles in the sample, sampling material, and sample container walls, necessitating filtration. The SAP should specify if filtration is necessary for samples. Filtration should be done as soon as possible after a water sample is obtained, preferably simultaneously with the production of the water. Where possible, the standard procedure should be to use an in-line flow-through filter. Refer to the SAP for direction as to whether the metals and/or radionuclides need to be filtered.

2.12 Sample Preservation and Handling

Sample preservation is required for many of the chemical constituents and physiochemical parameters that are not chemically stable but are measured or evaluated in a ground water sampling program. Methods of sample preservation are generally intended to retard biological action, retard hydrolysis, and reduce sorption effects. Preservation methods usually include pH control, chemical addition, refrigeration, and protection from light. Specific preservation methods for each constituent are found in the SOW for the analytical services. A summary list of appropriate sample container types and sample preservation is found in Table 2. Appropriate chemical preservation is performed in the field for the various analytical parameters at the time of sampling. Indicate the type and amount of preservation used in the field logbook.

Samples should be preserved at approximately 4°C in the dark during transport to the laboratory for analysis, excepting samples for metals and radionuclide analysis.

A documented chain-of-custody program shall be used to identify and trace all samples, from the point of collection to final analysis. The procedures for following this chain-of-custody and proper sample handling and packaging is outlined in ERP-SOP-11.3 *Chain-of-Custody, and ERP-SOP-11.3.1 Sample Handling, Packaging and Shipping.*

2.13 Field Quality Control Samples

The SAP should provide for the routine collection and analysis of the following field QC samples: trip blanks, field blanks, equipment blanks, and duplicate samples. A trip blank is used for purgeable organic compounds only. Trip blanks are typically prepared by the analytical lab sent to the project site and stored with precleaned sample containers, taken to sampling location and treated like a sample from that point on and travel with the collected VOA samples. Trip blanks are not opened and are returned and analyzed with the project samples. A field blank is prepared in the field with organic-free water. Fill a vial with organic-free water and follow all other sampling and handling practices. The sample accompanies the project samples to the laboratory and are analyzed for specific chemical parameters unique to the site at which they are prepared. The equipment blank is collected from the field equipment rinsate as a check for decontamination thoroughness. Pour organic-free water through or over the cleaned equipment and collect water in sample bottle and return to laboratory for analysis. Duplicates are collected as "second samples" from a selected well. They are collected as either split samples (collected from the same bailer volume or pumping discharge) or as second-run samples (separate bailer volumes or different pumping discharges) from the same well.

2.14 Transportation of Samples

Make prior arrangements for timely delivery of the samples to the analytical laboratory. All on-site and off-site shipments must follow DOT 49 CFR shipping requirements. EG&G Form 176 "Request for Shipment of Materials" will be filled out for off-site shipments and will accompany the shipment to its final destination. If the total activity level of the sample is above EG&G and DOT 49 CFR standards (0.002 pCi/L), procedures for shipping radioactive materials will be implemented. DOE-ID Form 5480 will be filled out prior to removing the sample from the site. Requirements regarding transportation of samples of potentially hazardous material, on the INEL, are detailed in EG&G Company Procedure 14.1 *Onsite Transportation of Hazardous Material.*

Samples collected from a controlled radioactive area must be surveyed by an HP technician and if clean a release tag will be issued prior to removing from the site.

2.15 Departure from the Site

When leaving the site ensure the well cap is replaced and locked, the area is policed for trash, and the pump and power is off. Return keys or any other plant property and inform contacts of any unusual circumstances.

3.0 DEFINITIONS

Duplicates/replicates-are collected as "second samples" from a selected well and/or project site. They are collected as either split samples (collected from the same bailer volume or pumping discharge) or as second-run samples (separate bailer volumes or different pumping discharges) from the same well.

Equipment blanks-are collected from the field equipment rinsate as a check for decontamination thoroughness.

Field Blanks-are prepared in the field with organic-free water. These samples accompany the project samples to the laboratory and are analyzed for specific chemical parameters unique to the site at which they were prepared.

Trip blanks-are used for purgeable organic compounds only. They are sent to the project site and travel with the collected samples. Trip blanks are not opened and are returned and analyzed with the project samples.

4.0 REFERENCES

DOE, 1989. *DOE Environmental Survey Manual, Appendix E, "Field Sampling Protocols and Guidance."* DOE Office of Environmental Audit.

EG&G, 1991a, *Quality Plan for the Environmental Restoration Program, QPP-149*, EG&G Idaho, Inc., Idaho Falls, Idaho.

EG&G, 1991, *Environmental Standard Operating Procedures, ERP-SOP-11.2 Field Logbooks*, EG&G Idaho, Inc., Idaho Falls, Idaho.

EG&G, 1991, *Environmental Standard Operating Procedures, ERP-SOP-11.3 Chain-of-Custody*, EG&G Idaho, Inc., Idaho Falls, Idaho.

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EG&G, 1991, *Environmental Standard Operating Procedures, ERP-SOP-11.5 Field Decontamination of Sampling Equipment*, EG&G Idaho, Inc., Idaho Falls, Idaho.

EG&G, 1991, *Environmental Standard Operating Procedures, ERP-SOP-11.9 Measurement of Ground Water Levels*, EG&G Idaho, Inc., Idaho Falls, Idaho.

EG&G, 1991, *EG&G Company Procedure 14.1 Onsite Transportation of Hazardous Material*, EG&G Idaho, Inc., Idaho Falls, Idaho.

United States Environmental Protection Agency, 1986, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*, Office of Waste Programs Enforcement, Office of Solid Waste and Emergency Response, Washington DC.

Table 1. Field Equipment List.

Appropriate field logbooks

Data Forms

Pencils, pens, permanent markers

Key to unlock wellhead

Watch

Electronic water-level measuring device or

Weighted steel tape marked
in hundredths of ft

Chalk

Safety equipment specified in
Health and Safety Plan

Flashlight

Mirror

Pump, bailer, bailer line

Purge hosing

Bucket

Specific conductance, dissolved oxygen,
pH, and temperature sensing devices, calibrated buffer solutions

Sampling Manifold

Sample bottles, preservatives

Pipette or eye dropper for
dispensing preservatives

Reagent grade water

Tape- clear tape for bottles,
parafilm, strapping tape and duct tape

Vermiculite

Chain-of-Custody Forms

Custody Seals

This-side-up Arrows

Address labels for coolers

Coolers

Blue Ice

Ziploc baggies

Plastic trash bags

Tools

Appropriate containers
for purge water, as applicable

Scissors, knife

Shipping papers, forms

Table 2. Typical ground water sample requirements.[c]

Analytical Parameter	Container		Preservative	Holding Time[a]	Sample Volume
	Size	Type			
Volatile organics	40 ml	amber glass vial	4° C 4 drops HCL	14 days	80 ml/ 2x40 ml (6x40 ml for full QC)[b]
Semivolatile organics PCBs/pesticides organophosphorus pesticides/ organochlorine herbicides	1 L per analysis	amber glass jugs	4° C	extract 7 days, analyze 40 days	1 L per analysis (pest., herb., etc.) 3 x 1L (for full QC)[b]
Nitrate	1000 ml	HDPE	4° C pH<2 H_2SO_4	14 days	1000 ml
Anions	125 ml	HDPE (NM)	4° C	28 days 48 hrs NO_3, PO_4	125 ml
All metals/cations	1000 ml	HDPE (NM)	pH<2 HNO_3	6 months Hg 28 days	1 L
Cr^{6+}	500 ml	HDPE (NM)	4° C	24 hrs	500 ml
Cyanide	1000 ml	HDPE (NM)	pH>12 NaOH .6g ascorbic acid	14 days	2 x 1L (for full QC)[b]
Sulfide	500 ml	glass(NM)	pH>9 NaOH/Zinc acetate	7 days	3 x 500 ml (for full QC)[b]
Alkalinity	500 ml	HDPE (NM)	4° C	14 days	500 ml
Suspended particles	500 ml	HDPE (WM)	4° C	7 days	500 ml
Gross alpha, beta screen	125 ml	HDPE (NM)	pH<2 HNO_3	screen immediately	100 ml
Gamma analysis or screen	540 ml	plastic	pH<2 HNO_3	1 year	500 ml
Rad. analysis/Total U	2-1/2 gal	plastic	pH<2 HNO_3	1 year	4 L
Sr-90	1000 ml	HDPE (NM)	pH<2 HNO_3	--	1000 ml
Tritium	125 ml	HDPE (NM)	none	1 year	100 ml

a. Holding times are from the date of collection as referred to in Federal Register Vol. 49, No. 209, October 26, 1984.
b. One sample for full QC is required for each project or every 20 samples, whichever is greatest.
c. Additional guidance on sample bottle and preservative requirements can be obtained from the ERD SMO.

Figure 1. Well Purging Field Measurement Data Sheet.

WELL PURGING DATA SHEET Well Number:____________________

Start Date______________ Time____________
End Date________________ Time____________
Total Well Depth________________________
Well Diameter___________________________

Development Team________________
____
____
____

Sample #	Time	Temperature	pH	Specific Conductance	Dissolved Oxygen

Pre-Purge Water Level Reading______________________________ (ft bls)
Post-Purge Water Level Reading_____________________________ (ft bls)
Calculated Purge Volume__________________________________ (gallons)
Actual Purge Volume______________________________________ (gallons)
Pump Flow Rate____ (gpm)

Appendix C, Part 2
GESOP 9, Measurement of Groundwater Levels

ENVIRONMENTAL RESTORATION DEPARTMENT
ENVIRONMENTAL STANDARD OPERATING PROCEDURE
COVER SHEET

INFORMATION ONLY

SOP Number: SOP-11.9 Revision: 0

Title: **STANDARD OPERATING PROCEDURE FOR MEASUREMENT OF GROUND WATER LEVELS**

Prepared by: K. N. Keck Date: 02/26/92
K. N. Keck, Sr. Scientist
Geosciences Group

Reviewed by: J. P. Shea Date: 02/27/92
J. P. Shea, Chairman
ERD Independent Review Committee

Approved by: Lois C VanDeusen Date: 2/28/92
L. C. VanDeusen, Manager
Site Remediation Group

Approved by: R L Norland Date: 2/28/92
R. L. Norland, Manager
Buried Waste Program (WAG 7) Group

ENVIRONMENTAL STANDARD OPERATING PROCEDURES MANUAL	TITLE: **MEASUREMENT OF GROUND WATER LEVELS** NUMBER: 11.9 ISSUE DATE: 02/28/92

1. PURPOSE AND SCOPE

To provide general instructions for Field Personnel to measure ground water levels in wells intercepting both regional and perched water systems. This information may be used to determine the regional groundwater flow direction and to determine water level fluctuations. Also, prior to bailing, purging, and/or sampling, calculate the static water level in the well and the volume of standing water in the well.

2. PROCEDURE

2.1 Each well should have a permanent, easily identified measuring point from which its water level measurement is taken. The measuring point is established to the nearest 0.01 foot by a licensed surveyor in relation to an established National Geodetic Vertical Datum (NGVD). In remote areas, a temporary benchmark is established to facilitate resurveying.

2.2 The measurement will be taken to 0.01 foot. The device used to detect the water level surface is sufficiently sensitive so that a measurement to ±0.01 foot is obtained reliably. A weighted water level steel or fiberglass measuring tape, electronic water level indicator, or transducer will suffice.

2.3 As a field calibration check, all new or newly repaired electronic water level indicator are checked against a weighted measuring tape in at least one well, prior to use.

2.4 Whenever nondedicated equipment is used, procedures as outlined in ERP-SOP-11.5, "*Field Decontamination of Sampling Equipment*" are instituted where wells are suspected or known to be contaminated.

2.5 At contaminated sites fumes and gases may be present, requiring both radiologic and hazardous constituent monitoring equipment. Refer to the site-specific Health and Safety Plan and/or safe work permit, for the proper personal protective equipment (PPE) required.

2.6 Material and equipment to perform groundwater level measurements include:

a. Black or dark colored pen or permanent non-smearable marker of a color that will copy.

b. Appropriate "Measurement of Groundwater Levels" (MGL) Forms (see Figure 1).

c. Keys and/or combinations for all well head protective casings and/or continuous recorder housing locks.

d. Weighted water level measuring tape with length greater than the anticipated water depth, or electronic water level indicator, or continuous recorder.

e. Carpenters' chalk (if using weighted measuring tape).

f. Portable computer and cable assembly for downloading water level measurements to magnetic disks and/or drum charts (as appropriate for continuous recorder)

2.7 If a weighted measuring tape is used, the water-level measurement should proceed in the following order:

a. Rinse the first ten feet of the measuring tape with detergent solution, then with distilled water and dried with a clean cloth. If previous measurements have been made at this well refer to them to estimate where to hold the measuring tape.

b. Chalk the lower segment (3-5 ft) of the tape by carefully drawing the tape across a piece of carpenter's chalk. Chalk need not be used on stainless-steel tapes.

c. Lower the weighted tape slowly down the center of the casing or riser pipe until the tape penetrates the water surface.

d. After water is encountered in the well, hold the tape at the closest even foot marker at the measuring point (typically top of well casing on north side). Make a note in field logbook and MGL form of measuring point location. If a measuring point is not identified on the well casing or apron, mark the measuring point where the tape is held at the top of the casing, so that successive measurements are taken from the same point. Record the "hold" measurement in feet on the MGL Form (see Figure 1).

Note: If a measuring point is not marked on the well contact the area landlord or appropriate personnel to have a measuring point permanently marked on the well and recorded in the INEL Comprehensive Well Survey Database.

e. Pull or reel the measuring tape out of the well.

f. Record the measurement to the nearest 0.01 ft where the tape became wet on the MGL form.

g. Depth to water (DTW) is found by subtracting the "wet" measurement from the "hold" measurement. Record depth to water to the nearest 0.01 ft on the MGL form.

h. Water-level elevation relative to mean sea level is found by subtracting the depth to water from the measuring point elevation.

i. Repeat the measurement and compare the DTW measurements with past measurements at this well, if available. If the value is inconsistent with past values or if this is the first measurement at this well, repeat the measurement and record the results in the MGL form.

j. Repeat step 2.7a.

2.8 If an electronic water-level indicator is used, the water-level measurement proceeds as follows:

a. Check battery condition and continuity as recommended in the owners' manual. The continuity cell can be tested by placing it in water and observing the audio or visual signal.

b. Measurement markers on the wire may slip or move out of place. Periodically, check that the measurement markers on the wire have not shifted with a tape measure.

c. Clean the first ten feet of the electric tape with detergent solution; rinse with distilled water; and dry it with a clean cloth.

d. Slowly lower the probe into the center of the casing until a contact with the water surface is indicated. Raise and lower the probe several times to ascertain surface water level. Use caution so that the electric tape is not cut by a sharp casing edge. Record the measurement to the nearest 0.01 ft on the MGL form; the reading represents DTW.

Note: If the tape is not incremented in 0.01 ft, measure (using folding ruler or tape measure with 0.01 ft increments) the distance from the "hold" mark to the nearest tape band or marker and add or subtract to the band or marker reading. Repeat the reading before pulling out the electronic water-level indicator. Record all measurements on the MGL form.

e. Reel the probe out of the well.

f. Compare the DTW measurement with past measurements at this well, if available. If the value is inconsistent with past values or if this is the first measurement at this well, repeat the measurement and record the results in the MGL form.

g. Water-level elevation relative to mean sea level is found by subtracting the depth to water from the measuring point elevation.

h. Repeat step 2.8c.

2.9 If a continuous recorder is used, the water-level measurement proceeds as follows:

a. Check batteries prior to use in the field to ensure an adequate power supply for the recorder. Reset (or set, if an initial installation) the downhole float or the transducer, as appropriate in compliance with the manufacturers' operating manual.

b. For initial installation, install the recorder at the wellhead and fit the supplied weatherproof housing as specified in the owners' manual. Install a new chart (for drum recorders) or initiate the data recording function as necessary. Initial and date the chart or disk and specify well number. Recheck all operating functions.

c. For routine maintenance, change the chart or download data onto magnetic disks, as appropriate for the type of recorder. Initial and date the chart or disk and specify well number.

d. Water-level elevation relative to mean sea level is found by subtracting the depth to water from the measuring point elevation.

3. DEFINITIONS

Depth to Water (DTW)- is the depth from the MP to the water level intercept point.

Land Surface Datum (l.s.d.)- is a surveyed benchmark indicating the true elevation at the land surface, generally identified by a brass marker set in the concrete surrounding the well.

Measurement Point (MP)- is a fixed, clearly marked point of reference at the top of the well riser casing or on the apron, and where applicable, the protective casing; from which the depth to groundwater is measured.

4. REFERENCES

U.S. EPA, 1986. RCRA Groundwater Monitoring Technical Enforcement Guide (TEGD).

ERP Environmental Standard Operating Procedures Manual, 1992. ERP-SOP-11.5, Field Decontamination of Sampling Equipment.

MEASUREMENT OF GROUND WATER LEVELS (MGL) DATA SHEET

Project:____________________________

Site:_______________________________

Well Number:______________________
M.P. Description:__________________
M.P. Height above land:____________ (ft)
M.P. Elevation:____________________ (ft)
Land surface elevation:____________ (ft)

Date	Time	Hold (ft)	Wet (ft)	Depth to Water (below M.P.) (ft)	Elev. of Water (adj. to m.s.l.) (ft)	Remarks	Initial

Figure 1. Measurement of Ground Water Levels Data Sheet.

Appendix C, Part 3
ETSOP 58
Hydrolab Surveyor II

ETSOP-58 - CALIBRATION AND OPERATION OF THE HYDROLAB SURVEYOR II FOR pH, TEMPERATURE, AND CONDUCTIVITY MEASUREMENT

1. REFERENCES

Hydrolab Surveyor II Operating Manual, Hydrolab Corporation, 1986.

2. GENERAL

2.1 Types of Data Collected

Information obtained from this procedure includes measurements of aqueous samples for pH, temperature, and conductivity. Additional procedures in the Hydrolab operating manual include instructions for measuring dissolved oxygen, oxygen reduction potential (ORP), and depth.

2.2 Principle of Operation

After calibration procedures are completed, water samples are collected from the well head (or other water source) and measurements are taken for pH, temperature, and conductivity. If dissolved oxygen (DO) and/or ORP measurements are necessary, they are also carried out, assuming proper calibration procedures have been completed for these parameters. Field measurements for pH, temperature, and conductivity will be collected during both well development and well purging activities to monitor groundwater quality.

2.3 Limitations

There are generally no limitations for the Hydrolab, other than instrument design limitations, if proper calibration, operation, and handling are met. For additional information, see the operating manual for the Hydrolab.

3. EQUIPMENT NEEDS

1. <u>System Parts</u>. There are five main components to the basic Surveyor II. These are the display unit, the data cable, the sonde, the sample circulator, and the battery pack (see Figure 1 and the operating manual for component function).

2. <u>Calibration Equipment</u>. The following materials and equipment will always be needed to carry out the calibration operations:

   - The calibration cup and calibration cup soft cover
   - A supply of deionized water
   - A supply of granular potassium chloride reagent
   - The use of an analytical balance
   - A small supply of quinhydrone reagent
   - Buffer standards of pH 4.0, 7.0, 10.0
   - Dissolved oxygen sensor membranes
   - Scissors
   - Soft paper wipers (Kleenex[1])
   - A 1000-mL volumetric flask

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[1] Mention of specific products and/or manufactures in this document implies neither endorsement or preference, nor disapproval by the U.S. Government, any of its agencies, or EG&G Idaho, of the use of a specific product for any purpose.

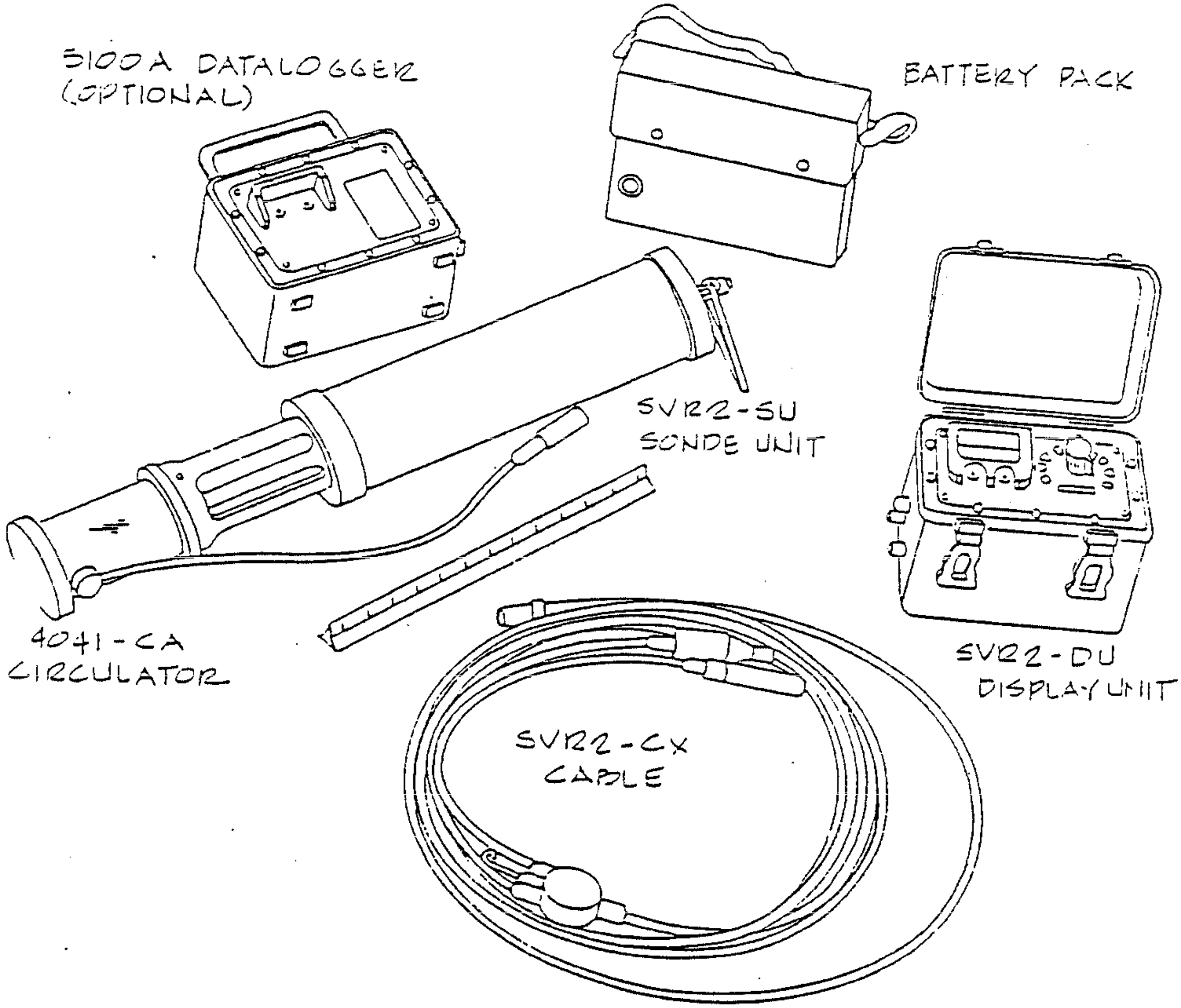

Figure 1. System components.

- A 500-mL volumetric flask
- A 100-mL volumetric flask
- A vise (clamp) for holding the sonde included with the Surveyor II
- Instrument calibration logbook.

The mechanical items that you will need continuously during calibrations are the vise (clamp) and the calibration cup and cover. The vise or clamp stand should be securely mounted to the benchtop near your deionized water supply and preferably near a sink.

4. PRECAUTIONS

4.1 Safety Considerations

- If the sample media is suspected of or known to contain hazardous and/or radiological contaminants, appropriate personal protective equipment and monitoring will be implemented as outlined in the site-specific health and safety plan
- After measurements have been carried out, sample water will be disposed of properly
- All equipment should be decontaminated after each use.

4.2 Transportation Considerations

Initial calibrations are often completed in the laboratory prior to leaving for the field site. In this case, excessive shock or vibration should be avoided as it can cause cumulative damage to sensitive system components and can negate calibrations. Cushion the instrument from vibrations.

4.3 Special Training Requirements

None.

4.4 Additional Precautions

- Do not let the sensors dry out. This can be avoided by keeping the storage cap, containing a little water, in place on the sonde.

- Do not allow the instrument to lie in direct sunshine or in such places as the closed trunk of a car for long periods, particularly in summer, because the temperatures inside the sealed display unit and sonde rise to very high levels. This will cause no permanent damage, but the operation of the system may be temporarily impaired (stability, calibration). Keeping the instrument in ventilated shade will avoid the heat problem.

- Very low temperatures should also be avoided. Try to keep the temperatures of the display unit and sonde higher than -10°C. Temperatures below -50°C might cause damage to vulnerable parts, such as the liquid crystal display of the display unit.

4.5 Calibration/Standardization

It is not necessary to wait until you arrive at the field site to calibrate. It is much easier to do careful, accurate calibrations under laboratory conditions. The stability of the Surveyor II is such that it will readily maintain calibration during transportation. If you feel better checking calibration in the field, do so, of course, but treat the findings as an intermediate postcalibration: record the results but do not adjust the system. Adjusting the instrument in the field destroys the value of the reliable laboratory postcalibration and may lead to loss of data quality control.

NOTE: Do not turn the Surveyor II off between calibration steps or your calibration factors will not be saved. Instructions for saving calibration factors are discussed in Section 4.5.5.

NOTE: All calibrations and post calibrations must be recorded in an instrument calibration logbook.

4.5.1 Frequency

The Surveyor II shall be calibrated each time it is taken into the field. However, it is not necessary to calibrate the Hydrolab between each sample.

4.5.2 Who Performs Calibrations

Field personnel familiar with the calibration and operation of the Hydrolab should perform the calibrations.

4.5.3 Conductivity

The most precise data will be obtained if the Surveyor II conductivity system is calibrated to fit the characteristics of the water being investigated. That is, if measurements are to be made in fresh water, the low conductivity range of the instrument should be calibrated and the mid and high ranges should be ignored. Or, if it is seawater that is being surveyed, the high conductivity range should be calibrated and the low and mid ranges should be ignored. (NOTE: The Surveyor II automatically switches to the range appropriate to the conductive values currently being measured, so you may have the feeling that there is only one range. Actually there are three: 0-1.5 mmhos/cm, 1.5-15 mmhos/cm, and 15-150 mmhos/cm with the standard cell; and 0-0.3 mmhos/cm, 0.3-3 mmhos/cm, and 3-30 mmhos/cm with the D-S cell attachment in place. If the D-S cell is required, consult the operating manual.

Standard solutions of potassium chloride salt are used for calibrating the conductive system of the Surveyor II. For maximum accuracy and convenience, it is best to make up concentrated stock solutions of the salt (one molar is suggested) and then to dilute to the concentrations desired. If the stock solution is always made the same, the weighings are always the same with less chance for number errors. Most importantly, there is no necessity for weighing out tiny amounts of KCl in order to achieve low concentrations. The conductivity ranges of the Surveyor II instrument have been so selected that simply by diluting one molar of KCl solution by multiples of 2 and 10, two benchmark solutions can be prepared for each of the low, mid, and high ranges. For example, the low conductivity range can be calibrated at 1.413 mmhos/cm using a 0.01 molar KCl solution. To achieve that concentration, dilute the 1.0 molar stock solution by 10 twice. If desired, check the low range at 0.718 mmhos/cm by using the solution resulting after diluting the 1.413 mmhos/cm solution by two.

A slightly different example would be preparing for seawater measurements. Seawater conductivities run in the low 50s mmhos/cm, so it would be best to calibrate the high range, not at 111.9 mmhos/cm, but at 58.64 mmhos/cm using the 0.5 molar solution obtained by diluting the stock solution by two.

Similarly, if you knew that your measurements would most probably lie in the neighborhood of 0.400 mmhos/cm, the low range would be better calibrated at 0.718 instead of 1.413 mmhos/cm.

In other words, try to calibrate above but as near as possible to the expected data range. However, if your field data should take an unexpected turn and fall into an uncalibrated range, do not worry about it. Go ahead and take your readings, calibrate the range later (postcalibration), and correct the readings if required.

Low Range		
0	0.718	1.413 mmhos/cm
0	0.005 M	0.01 M concentration
Mid Range		
0	6.668	12.900 mmhos/cm
0	0.05 M	0.1 M concentration
High Range		
0	58.640	111.900 mmhos/cm
0	0.5 M	1.0 M concentration

To make the stock solution, weigh out carefully 74.557 g of reagent grade KCl. Wash the KCl into a 1000-mL volumetric flask and fill to the mark with deionized water. Be sure that the KCl dissolves completely before use. The conductivity of the stock solution will be 111.900 mmhos/cm.

To dilute by two: Fill the 500-mL volumetric flask to the mark with the solution to be diluted. Transfer the 500 mL into the clean 1000-mL flask. Fill to the mark with deionized water.

To dilute by 10: Fill the 100-mL flask to the mark with the solution to be diluted. Transfer the contents of the 100-mL flask to the clean 1000-mL flask and fill to the mark with deionized water.

It is safe to keep the stock solution for a few weeks in a tightly sealed, all-glass container, but evaporation and contamination should be kept in mind. If there is any doubt, make a fresh stock of solution.

The critical items in the conductivity calibration are temperature and KCl concentration. Begin as follows:

1. Prepare the standard KCl solution whose conductivity will lie near the top of the range of your measurements.

2. Without removing the calibration cup, rinse the inside of the cup and sensor array several times with deionized water. If your deionized water comes from a tap, remove the sonde from the vise and hold the calibration cup under the tap.

3. Fill the calibration cup about two-thirds full with your standard. Cover the cup and shake the sonde to flush the sensors thoroughly with the standard. Discard the standard in the calibration cup and repeat. Discard the second portion of the standard. This procedure is to ensure that the concentration of the standard in the cup is what you want it to be.

4. Put the sonde in the vise, cup up.

5. Fill the cup to within about a centimeter of the top with standard. Be sure that no bubbles are trapped in the bores of the sensor.

6. Switch to temperature. You should find it quite stable by now.

7. Switch to conductivity. Use the slope control to adjust the displayed reading to the value of your standard.

8. The conductivity system is calibrated.

4.5.6 pH Calibration

Except in certain special situations, pH buffer solutions are the universal standards for pH calibration. There are buffers available with values over virtually the whole pH range, but the ones used the most have (at 25°C) the pH values 4.0, 7.0, and 10.0. Supplied in powder form, buffers should be prepared with deionized water according to the instructions provided. Buffer solutions will keep for a few weeks at room temperature and so can be made up and stored for calibration purposes.

For the best precision, you should calibrate for the range of pH values expected in the field. That is, for high pH water, calibrate at 7.0 and 10.0. For acid water, calibrate at 7.0 and 4.0.

Begin the pH system calibration as follows:

1. With the calibration cup screwed into place, flush the cup and sensors thoroughly with deionized water. Secure the sonde in the vise, cup up.

2. Fill the cup with pH 7.0 buffer sufficient to cover the membrane of the DO sensor. This is important because the DO sensor plays an indirect but essential part in the pH measurement.

3. Allow a minute or two for thermal equilibration. The importance of thermal equilibrium for measurements is very important, not only during calibration but also during measurements in the field.

4. Switch to pH. Now use the control to set the displayed value to 7.0. CAUTION: Be sure to use the zero control. The slope cannot have the correct effect.

5. Pour out the 7.0 buffer and flush the sensors with deionized water. CAUTION: It is hard to resist saving the buffer solutions used for calibration and if you are very careful, they can be retained and used a couple of times without causing errors. However, dilution and cross-contamination should be kept in mind as sources of trouble. Whenever in doubt, mix fresh buffers.

6. Fill the cup with pH 4.0 (or pH 10.0) buffer (cover the DO sensor) and allow a couple of minutes for equilibration.

7. Use the slope control to adjust the displayed reading to 4.0 (or 10.0).

8. Remove the 4.0 (or 10.0) buffer, flush the sensors, and check the reading with the 7.0 buffer once more.

9. The reading at 7.0 should have changed little, if at all. If it did change slightly, repeat Steps 5 through 8.

10. This completes the pH calibration.

4.5.5 Saving Calibration Settings

Now that the Surveyor II has been given all of the calibration information via the zero and slope controls, it is necessary to tell the instrument to store the information in its permanent memory for use during all of the measurements to follow. Again, do not turn the instrument off until the calibration factors have been saved.

First set the function switch to "BATT," then push both control switches, simultaneously, away from the display (toward you). Wait until the word "SAVE" appears in the display.

This saving operation must be done at the end of the calibration procedure, every time. If it is not done, the instrument will use old calibration information from the last save, introducing systematic errors into data that would otherwise be correct.

Calibration of the Surveyor II is finished.

1. Turn the instrument off.

2. Remove the calibration cup from the sonde, half fill the storage cup with deionized water or tap water, and screw it onto the sonde (snugly so that it will not leak).

5. INSTALLATION

None.

6. OPERATING PROCEDURES

6.1 Moving to the Field

When transporting the Surveyor II, there are three things to be concerned about:

- Drying out of the sensors
- Extreme temperatures
- Vibration and shock.

The first of these will not happen if care is taken to keep the storage cup, containing a little water, in place on the sonde.

Do not allow the instrument to remain in direct sunshine or in such places as the closed trunk of a car for long periods, particularly in summer, because the temperatures inside the sealed display unit and sonde rise to very high levels. This will cause no permanent damage, but the operation of the system may be temporarily impaired (stability, calibration). Keeping the instrument in ventilated shade will avoid the heat problem.

Very low temperatures should also be avoided. Try to keep the temperatures of the display unit and sonde higher than -10°C. Temperatures below -50°C might cause damage to vulnerable parts, such as the liquid crystal display of the display unit.

Excessive shock and vibration can cause cumulative damage to the parts of the system. Never, for instance, carry the instrument loose in the bed of a truck or van. Similarly, nodes of extreme vibration sometimes develop at places in small boats powered by outboard engines. Cushion the instrument from these vibrations.

6.2 Field Operations

When you are to the point where you are ready to begin measurements:

1. Remove the storage cup from the sonde and screw the circulator in its place

2. Connect the circulator to the socket of the data cable

3. Connect the water sample

4. Place the sonde in the water and set the display unit switch to the desired parameter.

For the Surveyor II, there is only one item that you have to really concentrate on during field measurements: thermal equilibrium. With the exception of depth and batt, all of the measurements are functions of temperature. These functions are stored in the display unit, and it is programmed to correct for them before displaying the data. The corrections are based on the assumption that all of the sensors are at the same temperature as that of the water. If that equilibrium condition is not met, errors will creep into the displayed data values.

Thermal equilibrium is always lost for a brief time whenever the environs of the sonde change. This will be true when the sonde is first put into the water and whenever it is moved into cooler or warmer regions of the water column. All that you have to do to avoid errors from this cause is to wait for equilibrium to return before taking your reading. You can judge this by watching the display. In general, the dissolved oxygen sensor is the slowest to match its temperature to that of the water, so watch the DO reading. When it has just about stopped changing (changing very slowly), it is time to read all of the parameter values. (If you are not sure that you are allowing enough time for equilibration, take readings at the same location both as the sonde is lowered and again as it is recovered. If the descending and ascending readings at corresponding depths differ consistently, you are most likely reading quicker than conditions allow.)

If it becomes necessary to verify calibration in the field, check each parameter by measuring appropriate standards just as you did during the laboratory calibration. However, do not use the calibration controls to adjust the instrument. Just record the readings versus the standards used. If something has indeed changed, use these readings to make corrections later. Waiting for the results of the postcalibration before disturbing instrument settings avoids confusion and helps with overall data quality control.

It sometimes happens, for example with conductivity, that values actually encountered in the field unexpectedly fall outside of the range that was calibrated for initially; this is nothing to worry about. Go ahead with the readings and, during postcalibration, use an additional standard to extend the range to include the unexpected readings. Correct the data as required.

When measurements are complete or are to be interrupted for any reason, disconnect and remove the circulator. Screw the storage cup one-half full with clean water onto the sonde to avoid dryout of the sensors.

6.3 Postcalibration

1. Perform postcalibration before performing any sensor maintenance.

2. Follow the same procedure used in the initial calibration, preferably using the same equipment and standard solutions, but do not adjust the instrument using the calibration controls.

3. Simply write down the final readings of the standards and make them part of the data documents.

The value of the postcalibration results lies in what they can tell you about what happened to the sensors since the initial calibration. If the postcalibration readings duplicate the values of the standards, you can be confident that the sensors were responding properly to conditions in the water. On the other hand, if one or more of the postcalibration readings is out of tolerance, suspect:

- An error in either the initial or postcalibration. Such things as having forgotten to save the calibration information, using contaminated or deteriorated standards, or failing to allow for thermal equilibration could be the problem.

- Sensor fouling. Check the appearance of the sensors for stains or coatings: oils, clays, precipitates, fibrous material, biological material, etc.

- Instrument malfunction. Check battery voltage. Check for sensor damage. See "Malfunctions," Section 4, of the operating manual.

7. COMMON PROBLEMS AND SOLUTIONS

See the operating manual.

8. SPECIAL MAINTENANCE

8.1 Servicing the Sensors

In the interest of efficiency, you will want to spend a minimum amount of time servicing the sensors. But at the same time, the hours spent in the field have to produce high quality data. What, then, is the right amount of servicing effort? Try deciding on the basis of a careful visual examination of the sensors, the results of the postcalibration, and the behavior of the instrument in the field.

If the instrument is responsive and stable in the field, the postcalibration measurements are all in tolerance, and visual inspection (made after quick cleanup) reveals no problems, then the quick cleaning described below is all that is required.

On the other hand, irregular behavior in the measurement of any parameter in the field, out-of-tolerance postcalibration measurements, or visible trouble signs will help you decide exactly where and what additional work is needed. Information on servicing the instrument can be found in the operating manual.

Quick cleanup: Always begin sensor servicing simply by cleaning away silt, oil and grease, and soluble compounds. To do so quickly:

1. Fill the storage cup one-half full with warm detergent solution and screw it onto the sonde.

2. Shake the sonde vigorously to wash the sensors in the detergent solution.

3. Use a cotton-tipped swab and detergent solution to dislodge remaining foreign matter. Be sure that the threaded area and rubber sealing ring of the sonde endcap are free of grit.

4. Rinse the sensors and sonde endcap with tap or deionized water.

5. Visually check the sensor array for any of the following signs of trouble:

   - Slack, wrinkled, or perforated DO sensor membrane

   - Bubbles in the electrolyte under the DO membrane

   - Obstructions (other than the electrodes) inside the bores of the conductivity cell block

   - Evidence of coatings or precipitates on pH, reference, ORP, or DO sensors, conductivity electrodes

   - To perform further servicing, see the appropriate sections in the operating manual.

6. If this is to conclude servicing (field performance, postcalibration, visual all satisfactory), half fill the storage cup with water and screw it onto the sonde.

CAUTION: The glass pH electrode is very vulnerable to accidental damage while other sensors or parts of the system are being worked on. Make it a habit always to protect the electrode by slipping a piece of flexible, thick-walled tubing (Tygon) over it during servicing operations.

9. DATA RECORDED IN THE FIELD

Field data recorded as part of this procedure include:

- Calibration information for temperature, pH, and conductivity (if done in field)
- Name of calibrator
- Date and time of calibration
- Instrument number
- Type, lot, and manufacturer of calibration standards (if applicable)
- Date and time of field measurements
- Values measured for pH, temperature, and conductivity
- Postcalibration readings
- Sampling site identification and pertinent sampling information (e.g., volume of purge water for which sample was collected).

10. DATA REDUCTION

None, if field measurements fall within calibration limits. If field values are outside calibration limits, connections to the data are made after postcalibration procedures are completed.

11. DATA REPORTING

11.1 Units

pH: Standard units
Temperature: °C
Conductivity: mmhos/cm
Dissolved oxygen: mg/L

11.2 Precision

See the operating manual.

11.3 Accuracy

See the operating manual.

11.4 Comments

See the operating manual.

12. GENERAL QUALITY ASSURANCE/QUALITY CONTROL COMMENTS

None.

APPENDIX C

3. ETSOP-58 - CALIBRATION AND OPERATION OF THE HYDROLAB SURVEYOR II FOR pH, TEMPERATURE, AND CONDUCTIVITY MEASUREMENT

Appendix D
Packing, Labelling, and Shipping

APPENDIX D

Packaging, Labeling, and Shipping
(ETSOP-52)

APPENDIX D
PACKAGING, LABELING, AND SHIPPING
(ETSOP-52)

1. PURPOSE AND SCOPE

This appendix describes the packaging, labeling, and shipping used for environmental and hazardous samples collected at a waste site.

1.3 Responsibilities

Detailed responsibilities are described in the procedure subsection. General responsibilities are assigned as follows:

- Field team leaders will state, to the best of their knowledge, whether samples planned for collection are environmental or hazardous samples
- The equipment manager will procure shipping supplies (metal cans, shipping labels, vermiculite, etc.)
- Sampling personnel will properly label and package samples.

2.0 PROCEDURES

2.1 PREREQUISITES

The procedures described in this subsection are carried out after the sample preservation per the Sampling Analysis Plan.

2.2 QA/QC

Internal QC will be performed in accordance with ERD QPP-149, Section 11 (EG&G Idaho 1991a) except where deviations are stated in the SAP and as approved by the project quality engineer or designated alternative (i.e., RWMC quality engineer). Document review will be performed on all documents per ERD PD 2.2, "Internal and Independent Review of Documents." Laboratory QC samples and laboratory control charts will be processed as required by the laboratory SOW. Field QC samples will include trip blanks and field standards.

The initial responsibility for monitoring the quality of field measurements lies with the field personnel. The FTL is responsible for verifying that all QA procedures are followed. This requires that the FTL assess the correctness of field methods and their ability to meet QA objectives.

If changes are required, the FTL will make a subjective assessment of the impact a procedure change will have on field objectives and subsequent data quality. If a problem occurs that might jeopardize the integrity of the project, cause a QA objective not to be met, or impact data quality, the FTL will immediately notify his/her project supervisor.

It is the responsibility of the certified hazardous shipper to ensure that all samples have been label and packaged per 49 CFR Parts 178-199. He will provide a final review of the packaging and labeling of each sample before shipping to the appropriate analytical laboratory for analysis.

2.3 HEALTH AND SAFETY REQUIREMENTS

General operational health and safety requirements for performing this procedure will be addressed in the training required for shipping hazardous material and sampling activities. No additional specific health and safety requirements exist at this time.

2.4 TRAINING

Personnel assigned to perform this procedure will be briefed by the FTL of any additional job specific information required other than the standard training required for sampling and shipping of samples at the INEL.

2.5 PRECAUTIONS/LIMITATIONS

The penalties for improper shipment of hazardous materials are severe; a fine of $25,000 and 5 years imprisonment can be imposed for each violation. The FTL or designee is urged to take adequate precautions to ensure that packaging and shipping procedures are strictly followed.

2.6 MATERIAL AND EQUIPMENT

The equipment manager will procure shipping supplies (metal cans, shipping labels, vermiculite, etc.)

2.7 CALIBRATION/STANDARDIZATION

Not Applicable

2.8 TRANSPORTATION

The procedures described in this subsection apply to samples collected at a waste site. They must be followed whether shipping to a Contract Laboratory Program laboratory or a noncontract laboratory.

The shipment of hazardous materials is governed by the Transportation Safety Act of 1974. The following is a list of references that detail the regulations:

- Title 49 CFR
    - Parts 171-177: shipper requirements and hazardous material table
    - Parts 178-199: packaging specifications
    - Section 262.20: hazardous waste manifest

- International Civil Aviation Organization (ICAO) Regulations
    - Technical instructions for the safe transport of dangerous goods by air (lists mandatory international and optional domestic regulations)
- International Air Transport Association
    - Dangerous goods regulations [this tariff incorporates 49 CFR, ICAO, and additional International Air Transport Association (IATA) regulations; most international and domestic airlines belong to IATA and require conformance to all applicable regulations].
- Tariff BOE-6000-D (reprint of 49 CFR with updates).

2.9 PROCEDURE DESCRIPTION/INSTALLATION

2.9.1 Environmental Samples

Low-concentration samples are defined as environmental samples and should be packaged for shipment as follows:

1. A sample tag is attached to the sample bottle.
2. All bottles, except the volatile organic analysis (VOA) vials, are taped closed with parafilm (or other tape as appropriate).
3. Each sample bottle is placed in a separate plastic bag, which is then sealed. As much air as possible is squeezed from the bag before sealing.

4. A picnic cooler (such as a Coleman[a] or other sturdy cooler) is typically used as a shipping container. In preparation for shipping samples, the drain plug is taped shut from the inside and outside, and a large plastic bag is used as a liner for the cooler. Approximately 1 in. of packing material, such as asbestos-free vermiculite, perlite, or styrofoam beads, is placed in the bottom of the liner bag. Other commercially available shipping containers may be used. However, the use of such containers (cardboard or fiber boxes complete with separators and preservatives) should be specified in the sampling plan.

5. The bottles are placed in the lined picnic cooler. Cardboard separators may be placed between the bottles at the discretion of the shipper.

6. Water samples for low- or medium-level inorganics analysis <u>must</u> be shipped cooled to 4°C with ice. <u>No ice</u> is to be used for shipping inorganic low-level soil samples or medium/high-level water samples, organic high-level water or soil samples, or dioxin samples. Ice is not required for shipping soil samples, but may be used at the option of the sampler. All cyanide samples, however, must be shipped cooled to 4°C.

7. The lined cooler is filled with packing material (such as asbestos-free vermiculite, perlite, or styrofoam beads) and the large inner (garbage bag) liner is taped shut. Sufficient packing material should be used to prevent sample containers from making contact during shipment.

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[a] Mention of specific products and/or manufacturers in this document implies neither endorsement or preference, nor disapproval by the U.S. Government, any of its agencies, or EG&G Idaho, of the use of a specific product for any purpose.

8. The paperwork going to the laboratory is placed inside a plastic bag. The bag is sealed and taped to the inside of the cooler lid. A copy of the COC form should be included in the paperwork sent to the laboratory. The last block on the COC form should indicate the overnight carrier and air-bill number. The air bill must be filled out before the samples are handed over to the carrier. The laboratory should be notified if another sample is being sent to another laboratory for dioxin analysis or if the shipper suspects that the sample contains any other substance for which the laboratory personnel should take safety precautions.

9. The cooler is closed and padlocked or taped shut with strapping tape (filament type).

10. At least two signed custody seals are placed on the cooler, one on the front and one on the back. Additional seals may be used if the sampler or shipper thinks more seals are necessary.

11. The cooler is handed over to the overnight carrier, typically Federal Express. A standard air bill is necessary for shipping environmental samples. Clear tape is placed over the seals.

2.9.2 Hazardous Samples

Medium- and high-concentration samples are defined as hazardous and must be packaged as follows:

1. A sample tag is attached to the sample bottle.

2. All bottles, except the VOA vials, are taped closed with electrical tape (or other tape as appropriate). Evidence tape may be used for additional security.

3. Each sample bottle is placed in a plastic bag, and the bag is sealed. For medium-concentration water samples, each VOA vial is wrapped in a paper towel and the two vials are placed into one bag. As much air as possible is squeezed from the bags before sealing. Evidence tape may be used to seal the bags for additional security.

4. Each bottle is placed in a separate paint can, the paint can is filled with vermiculite, and the lid is fixed to the can. The lid must be sealed with metal clips or with filament or evidence tape; if clips are used, the manufacturer typically recommends six clips.

5. Arrows are placed on the can to indicate which end is up.

6. The outside of each can must contain the proper Department of Transportation (DOT) shipping name and identification number for the sample. The information may be placed on stickers or printed legibly. A liquid sample of an uncertain nature is shipped as a flammable liquid with the shipping name "FLAMMABLE LIQUID, N.O.S." and identification number UN1993. A solid sample of uncertain nature is shipped as a flammable solid with the shipping name "FLAMMABLE SOLID, N.O.S." and identification number UN1325. If the nature of the sample is known, 49 CFR 171-177 is consulted to determine the proper labeling and packaging requirements.

7. The cans are placed upright in a cooler with the drain plug of the cooler taped shut inside and out. The cooler should be lined with a garbage bag. Vermiculite is placed on the bottom. Two sizes of paint cans are used: half-gallon and gallon. The half-gallon paint cans can be stored on top of each other; however, the gallon cans are too high to stack. The cooler is filled with vermiculite and the liner is taped shut.

8. The paperwork going to the laboratory is placed inside a plastic bag and taped to the inside of the cooler lid. A copy of the COC form should be included in the paperwork sent to the laboratory. The sampler keeps one copy of the COC form. The laboratory should be notified if a parallel sample is being sent to another laboratory for dioxin analysis, or if the sample is suspected of containing any substance for which laboratory personnel should take safety precautions.

9. The cooler is closed and sealed with strapping tape. At least two custody seals are placed on the outside of the cooler (one on the front and one on the back). More custody seals may be used at the discretion of the sampler.

10. The following markings are placed on the top of the cooler:

    - Proper shipping name (49 CFR 172.301)
    - DOT identification number (49 CFR 172.301)
    - Shipper's or consignee's name and address (49 CFR 172.306)
    - "This End Up" legibly written if shipment contains liquid hazardous materials (49 CFR 172.312).

    Other commercially available shipping containers may be used. The field team leader (FTL) should ascertain that the containers are appropriate to the type of sample being shipped. The FTL should clearly specify the type of shipping container to be used in the quality assurance project plan.

11. The following labels are required on top of the cooler (49 CFR 172.406e):

- Appropriate hazard class label (placed next to the proper shipping name)

- "Cargo Aircraft Only" (if applicable as identified in 49 CFR 172.101).

12. An arrow symbol(s) indicating "This Way Up" should be placed on the cooler in addition to the markings and labels described above.

13. Restricted-article air bills are used for shipment. The "Shipper Certification for Restricted Articles" section of the air bill is filled out as follows for a flammable solid or a flammable liquid:

    - Number of packages or number of coolers

    - Proper shipping name: if unknown, use either

        - Flammable solid, N.O.S.
        - Flammable liquid, N.O.S.

    - Classification; if unknown, use either

        - Flammable solid
        - Flammable liquid

    - Identification number; if unknown, use either

        - UN1325 (for flammable solids)
        - UN1993 (for flammable liquids)

    - Net quantity for package amount or amount of substance in each cooler

    - Radioactive materials section (leave blank)

- Passenger or cargo aircraft (cross off the nonapplicable. Up to 25 lb of flammable solid per cooler can be shipped on a passenger or cargo aircraft. Up to 1 qt of flammable liquid per cooler can be shipped on a passenger aircraft, and up to 10 gal of flammable liquid per cooler can be shipped on a cargo aircraft.)

- Name and title of shipper (printed)

- An emergency telephone number at which the shipper can be reached within the following 24 to 48 hours.

- Shipper's signature.

2.9.3 Records

The user should refer to the task-specific sampling and analysis plan for discussion of the records associated with sample collection and chain-of-custody forms.

The following records are associated with the labeling and shipping process:

- Sample tag or label

- Traffic report label

- Custody seal

- Chain-of-custody (COC) form

- Bill of lading (air bill or similar document).

2.9.4 Information Sources

CH_2M Hill, REM/FIT Documentation Protocol for Region V, May 1984.

Code of Federal Regulations, Title 49, Parts 171 to 177, "Transportation."

U.S. Environmental Protection Agency, Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, Region IV, Environmental Services Division, April 1, 1986.

U.S. Environmental Protection Agency, The User's Guide to the Contract Laboratory Program, Office of Emergency and Remedial Response, December 1986.

3.0 DEFINITIONS

Low-Concentration Sample - The contaminant of highest concentration is present at less than 10 parts per million (ppm). Examples include background environmental samples.

Medium-Concentration Sample - The contaminant of highest concentration is suspected of being present at a level greater than 10 ppm and less than 15% (150,000 ppm). Examples include waste materials onsite that are obviously weathered.

High-Concentration Sample - At least one contaminant is suspected of being present at a level greater than 15%. Samples from drums and tanks are assumed to be high concentration unless information indicates otherwise.

Routine Analytical Services - Analysis of a soil or water sample on a 30- to 45-day turnaround time for a list of 126 organics, 23 metals, and cyanide.

Field Team Leader - The individual responsible for the successful completion of a work assignment within budget and schedule. The person is also referred to as the site project manager or the project manager and is typically a contractor's employee.

4. REFERENCE

1.1 U.S. Environmental Projection Agency, <u>A Compendium of Superfund Field Operations Method</u>, U.S. Environmental Monitoring System Laboratory, P.O. Box 15027, Las Vegas, Nevada 89114-5027, EPA-540/P-87-001. December 1987.

Appendix E
Flux Tests

APPENDIX E

Flux Tests
(ETSOP-59)

APPENDIX E
FLUX TESTS
(ETSOP-59)

1. PURPOSE AND SCOPE

The rate of volatile organic compound (VOC) transport (i.e., VOC flux) across the soil surface and to the ambient air is an important variable in understanding VOC migration and performing the air pathway analysis. The purpose of these flux tests is to estimate the flux of VOCs emitted from the Subsurface Disposal Area (SDA) during each of the Idaho seasons (quarterly), while simultaneously estimating the surface soil moisture conditions, surface permeability, and temperature.

2. ACRONYMS/DEFINITIONS

EPA	U.S. Environmental Protection Agency
ETSOP	Environmental Technology Standard Operating Procedure
GC	gas chromatograph
NBS	National Bureau of Standards
PID	photoionization detector
SOP	standard operating procedure
VOC	volatile organic compound

3. DESCRIPTION

The flux test at each designated location will include the following measurements to: (1) estimate surface soil temperature using a thermocouple (shaded from the sun), (2) estimate the flux of VOCs from the surface using an emission isolation flux chamber, Tedlar sample bags, and a gas chromatograph using detailed procedures outlined in EPA/600/8-86/008, (3) estimate the surface permeability to air using the surface permeameter (Tanner and Wengel 1957), and (4) estimate soil moisture content using a surface moisture gauge.

4. PRECAUTIONS/LIMITATIONS

Snow cover, heavy rainfall, and/or high winds could all potentially compromise the data quality from these tests, and these conditions should be avoided if at all possible. Training requirements for the operation of the flux chamber, thermocouple, surface permeameter, and soil moisture gauge will be met during the calibration phase where the responsible scientists/technicians will perform the calibration and practice sampling/measuring using procedures provided in this standard operating procedure (SOP) and EPA/600/8-86/088.

5. PREREQUISITES

All proposed sampling locations will be permanently marked and documented accordingly. All equipment will be calibrated as necessary, and all necessary equipment, supplies, and documentation will be available prior to beginning this procedure.

6. CALIBRATION/STANDARDIZATION

The temperature measuring thermocouple will be calibrated to a National Bureau of Standards (NBS) certified or equivalent thermometer at the beginning of each quarterly set of measurements. The flowmeter in the flux chamber will be calibrated against an NBS traceable bubble meter before each quarterly set of flux tests is performed. The surface permeameter and soil moisture gauge will be calibrated/standardized in accordance with the manufacturer's instructions at the beginning of each quarterly set of measurements. Gas chromatograph (GS) calibration is discussed in a separate SOP for the operation of that instrument.

7. MATERIALS/EQUIPMENT

The following list references the necessary equipment and materials required to perform the flux tests:

1. Thermocouple with sun shield

2. Soil moisture gauge (CPN Hydroprobe)
3. Isolation flux chamber system (as described in EPA 600/8-86/088)
4. Portable photoionization detector (PID) for volatile organic vapor monitoring
5. Tedlar bags
6. Gas chromatograph
7. Surface air permeameter and appurtences
8. Logbooks and miscellaneous supplies, as required.

8. INSTALLATION

No special procedures or requirements apply.

9. PROCEDURE

9.1 Surface Soil Temperature

9.1.1 Check battery condition and thermocouple connections.

9.1.2 Place thermocouple (with sun shield) on designated sample location.

9.1.3 Allow temperature to equilibrate (fluctuation should be less than ±1°C).

9.1.4 Record date, time, and temperature in field logbook.

9.2 Isolation Flux Chamber

Follow setup, calibration, and sample collection procedure detailed in Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber, EPA 600/8-86/088, and substitute a Tedlar bag for containerizing the sample in lieu of a passivated stainless steel canister. A portable PID may be used at the field team leader's discretion to screen the samples collected by the flux chamber for total VOCs prior to gas chromatograph analysis. Vapor sample analysis will be in accordance with a GC-specific SOP.

9.3 Surface Permeameter

The surface permeameter will be operated in accordance with Tanner and Wengel (1957) and results recorded in the field logbook.

9.4 Soil Moisture

The soil moisture gauge will be operated in accordance with its manufacturer's instructions, and results recorded in the field logbook.

10. CALCULATIONS

See EPA 600/8-86/008 for a discussion of flux chamber calculations.

11. DATA REDUCTION

Soil temperature, moisture, and permeability do not require further data reduction, unless mean, maximum, and minimum values are reported. Data reduction for the flux chamber measurements (mean emission rate) can be found in EPA 600/8-86/008.

12. DATA REPORTING

Measurement	Units	Precision	Accuracy
Temperature	°C	—	±3°C
VOC emission rate (flux)	$ug/min*m^2$	±10%	±50%
Surface permeability	$L/min*m^2$	—	—
Soil moisture	$m^3\ H_2O/m^3$ soil	$\pm 0.003 m^3/m^3$	$\pm 0.005 m^3/m^3$

13. REFERENCES

Tanner and Wengel 1957.

EPA 600/8-86/088,008.

Appendix F
Soil Vapor Sampling

APPENDIX F

Active Soil Vapor Sampling with the Art's Manufacturing and Supply (AMS) Gas Vapor Probe (GVP) and Tedlar Bags

(ETSOP-48)

APPENDIX F
ACTIVE SOIL VAPOR SAMPLING WITH THE ART'S MANUFACTURING AND SUPPLY (AMS) GAS VAPOR PROBE (GVP) AND TEDLAR BAGS
(ETSOP-48)

1. REFERENCES

Art's Manufacturing & Supply, Operating Instructions for the AMS Gas Vapor Probe (Retract-a-Tip), 1990.

Art's Manufacturing & Supply, Operating Instructions for the AMS Dedicated Point Gas Vapor Probe, 1990.

Balfour, W. D., C. E. Schmidt, and B. M. Eklund, "Sampling Approaches for the Measurement of Volatile Compounds at Hazardous Waste Sites," Journal of Hazardous Materials, Vol. 14, 1987, pp. 135-148.

Devitt, D. A., R. B. Evans, W. A. Jury, and T. H. Starks, Soil Gas Sensing for Detection and Mapping of Volatile Organics, National Water Well Association Publication No. 49, 1987, p. 270.

EPA Office of Underground Storage Tanks, Laboratory Bypass Procedures: A Field Surgeon's Guide to Petroleum Contamination Assessment, prepared by Midwest Research Institute, 5109 Leesburg Pike, Suite 414, Falls Church, Virginia, November 1989.

Lockheed Engineering and Sciences Company, Draft Interim Guidance Document for Soil-Gas Surveying, prepared for P. B. Durgin, U.S. EPA Advanced Monitoring Systems Division, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, 1989.

Nadeau, R. J., J. P. Lafornara, G. S. Klinger, T. Stone, "U.S. EPA Environmental Response Team Methods for Measuring Soil Vapors for Defining Subsurface Contaminant Plumes," National Conference on

Management of Uncontrolled Hazardous Waste, Hazardous Materials Control Research Institute, 1985, pp. 22-26.

2. ACRONYMS

AMS	Art's Manufacturing and Supply
GVP	gas vapor probe
H&S	health and safety
ID	inside diameter
OD	outside diameter
SAP	sampling and analysis plan
SOP	standard operating procedure

3. DESCRIPTION

Sampling involves withdrawing soil vapors from the subsurface for subsequent analysis. The goal is to provide samples that are representative of the soil atmosphere with a high degree of reproducibility, so sample results from one point to another can be compared. Sample locations can be temporary or semi-permanent to provide long-term monitoring. This standard operating procedure (SOP) will ensure that all soil vapor samples will be obtained in a consistent manner.

Types of Data Collected. This standardized procedure will be used to collect samples for analysis to obtain information regarding the presence of volatile contaminants or their relative concentrations differences in the subsurface soil vapor. The method may also be used to indirectly determine the presence of volatile contaminants in the subsurface soil/groundwater. However, the method is not intended to be used to determine or infer contaminant levels in soil/groundwater.

Principle of Operation. Hollow, hardened steel probes equipped with either reusable or expendable drive tips are driven into the ground. Soil vapor is then drawn from the ground through flexible Teflon tubing inside the probe using an applied vacuum. Soil vapor can then be analyzed immediately by the appropriate analyzer or collected in a Tedlar bag and analyzed to estimate the concentration of volatile contaminants in the soil vapor.

Limitations. The major limitations in using these probes are that they are best suited for shallow sampling (less than 10 ft), they are not well suited for hard or rocky soils, they are of limited use where surface water and/or shallow groundwater is present, vapor ports in the probes may become clogged during installation, ambient air can migrate down the outside of the probe and dilute sample, and at depths less than 2 ft ambient air can migrate through the soil cover and dilute the sample. Other problems include the loss of volatiles during long residence times (greater than 30 minutes) in a Tedlar bag and the technique can be labor intensive.

4. PRECAUTIONS

Safety Consideration. Site safety planning must be an integral part of the sampling design. Safety concerns for soil vapor sampling are similar in most regards to those for other environmental investigation activities. The sampling technique may result in expelling concentrated vapors into the breathing space during purging, analysis, or decontamination. Therefore, the breathing space of field personnel working with collecting and analyzing samples must be routinely monitored during sampling. Although sampling may be done where contamination is confined to the subsurface, it is frequently performed at highly contaminated locations where contamination may not be limited to volatile compounds in the subsurface, but might also include semi- or non-volatile organic, inorganic, or radioactive substances and/or other potential health and safety (H&S) hazards. This may result in the field personnel touching probes or other equipment that has come into contact with contaminated soils. Prior to beginning the sampling, information about the site must be gathered and evaluated so that appropriate precautions are taken to protect the H&S of the field personnel. All precautions and concerns must be outlined in a site-specific H&S plan and followed at the direction of a site safety officer. Finally, because the technique can be labor intensive, precautions must be taken to prevent overexertion or heat stress of the field personnel.

Transportation Considerations. Not applicable.

Special Training Requirements. All field personnel must take the Occupational Safety and Health Administration 40-hour H&S training and any other site-specific training to perform field work. If decontamination or other sampling activities require the use of hazardous materials, field personnel must be made aware of these materials and where the Material Safety Data Sheets are located. Field personnel operating the Art's Manufacturing and Supply (AMS) equipment must read the manufacture's literature, watch the video "AMS Gas Vapor Probe," and familiarize themselves with the use of the equipment prior to working in the field.

Specific Health and Safety Concerns for Soil Vapor Sampling. Soil vapor sampling is intrusive and usually done as the first phase of an investigation in areas where there is limited information on subsurface conditions. Therefore, a thorough review of the site history and present condition must be done prior to sampling. In addition, precautions must be taken to identify buried utilities, piping, and drums or tanks. An agreement should be made ahead of sampling concerning who is responsible for locating these features, locating sample points, and any damages. Personnel should be briefed concerning what measures should be taken if damage occurs.

5. CALIBRATION/STANDARDIZATION

This method can provide relatively high sensitivity for detecting volatile compounds in the part per million (ppm) to the part per billion (ppb) range depending on the analytical instrumentation used.

Field instruments must be calibrated prior to taking sample measurements according to instrument documentation or an SOP. Single constituent and multiconstituent calibration curves to develop these standards may be used depending on the preference of the investigator or the objectives of the investigation. Several approaches are presented to the reader for developing field standards in the field. The approach taken should reflect field conditions and the data quality objectives of the investigation. The frequency and criteria for timing will be defined in the sampling and analysis plan (SAP). Specific instrument calibration will be defined in the instrument SOP. The approaches are listed below:

- A single component standard (i.e., benzene) is used to develop a calibration curve. Results are reported for other petroleum components as an equivalent of the standard.

- A second approach involves the serial dilution of a water sample. A relative concentration calibration curve is developed by plotting the results of the serial dilution analyses, which can later be semi-quantified by a laboratory analysis of the same sample.

- A third alternative specifies that a multicomponent standard having the same constituents in a similar proportion as that of the contaminated soil and/or water may be used to generate a calibration curve.

- A final method involves generating a calibration curve based on headspace readings from water samples obtained from one or more wells at the site where the concentration of contaminants has been previously determined.

6. INSTALLATION/OPERATING PROCEDURES

Step 1: Presampling Site Walk-Through

A reconnaissance walk of the study area must be conducted prior to the beginning of field work. If possible, someone familiar with the site should accompany field personnel and indicate where the boundary limits of the study area are located. Site conditions that could limit the usefulness of the soil vapor sampling should be noted (see "Limitations" subsection), along with any H&S concerns.

Step 2: Layout of Sample Locations

The grid pattern of planned sample locations should be staked out in the survey area. The parameters to consider in planning and designing a grid pattern are type of contaminant present; length of time contaminant has been present; known concentration of contaminant in soil/groundwater; depth, direction, and rate of flow of groundwater; soil type and geologic properties; number and location of subsurface structures; objective of the sampling; and any historical and/or anecdotal evidence of contamination. Once the grid pattern is staked out, the aforementioned parameters should be reevaluated and the grid pattern design modified if necessary.

Step 3: Equipment Checkout

All sampling equipment must be visually inspected for defects. All fittings/connections will be examined and adjusted as necessary to maintain the sampling system as leak-proof as possible. Before sampling, each component of the sampling system that can potentially introduce or come in contact with contamination needs to be cleanable or replaceable. After the sampling equipment is inspected, equipment blanks and sample container blanks must be taken using an ultra pure air supply (i.e., nitrogen, argon) as the sample medium.

The equipment list for one complete AMS gas vapor probe (GVP) includes:

(1) Three-ft-long, 5/8-in. outside diameter (OD) drive extensions
(1) Extension drive adapter
(1) Slide/hammer drive adapter
(1) Hammer/drill adapter
(1) 11-lb slide hammer
(1) Milwaukee 1-1/2-in. electric rotary hammer drill
(1) Retractable drive tip with screen

(1) Fifteen-ft-long section of 3/16-in. inside diameter (ID) Teflon tubing
(1) SKC Universal Sample Pump (Model 224-PCXR7) or other industrial hygienist vacuum pump, or the Mityvac hand-held vacuum pump supplied with the AMS GVP
(1) 1-L Tedlar bag
(3) 0.3-L Tedlar bag
(1) Hi-Lift jack
(1) Xitech vacuum box with inlet valve and hose fitting

Step 4: GVP Installation

Following equipment checkout (Step 3), a complete AMS GVP is assembled and advanced into the ground to the target depth specified in the SAP. Specific procedures are:

1. Cut a section of 3/16-in. ID Teflon tubing equal to the depth of sampling plus at least 2 ft. For example, if samples will be collected every 2 ft and the maximum depth of sampling will be 10 ft, then cut the 3/16-in. ID Teflon tubing 15 ft long. This will allow sufficient Teflon tubing at the surface for manipulation during sampling while providing standard equipment sizes for all soil vapor samples at the same site.

2. Screw the extension drive adapter (this piece has a hole drilled through the side and one end is tapped to accommodate drive extensions) onto one of the drive extensions. NOTE: It makes no difference which drive extension is used with the extension drive adapter.

3. Take one end of the precut 3/16-in. ID Teflon tubing, insert it into the extension drive adapter, and push it through the drive extension until the 3/16-in. ID Teflon tubing exits the open end of the drive extension.

4. Push the barbed Tang end of the GVP retractable tip all the way into the 3/16-in. ID Teflon tubing.

5. Screw the GVP retractable tip onto the opposite end of the drive extension. NOTE: When using the 5/8-in. OD drive extensions, the 1/2-in. ID drive collar on the GVP retractable tip must be removed. The 5/8-in. OD drive extension is then screwed directly into the GVP retractable tip. For a more detailed discussion of the GVP retractable tip, refer to the manufacturer's literature.

6. The first 3-ft section of the GVP drive extension is now ready to be driven into the ground. There are several methods available to do this.

   a. Slide hammer. If the probe is to be driven less than 6 ft deep or in a restrictive location (i.e., between cars), then the slide hammer attachment should be used. The slide hammer manually hammers the probe downward by lifting and dropping an 11-lb weight onto the extension drive adapter. The slide hammer drive adapter is used to attach the slide hammer to the extension drive adapter. The hexagonal end of the slide hammer drive adapter fits into the slide hammer and the circular end seats into the extension drive adapter.

   b. Hammer Drill. If the probe is to be driven deeper than 6 ft or in tight (i.e., clayey or wet) or rocky soils, then the Milwaukee 1-1/2-in. heavy duty electric rotary hammer drill should be used. The sculpted end of the rotary hammer drill adapter is inserted into the hammer drill and the sliding bar lock below the chuck on the hammer drill is closed so that the hammer drill adapter will not pull out. The circular end of the hammer drill adapter is then seated into the extension drive adapter.

c. Drill Rig. If the probes are to be driven deeper than 6 ft and there is good access to the sampling location, then the cathead/drop weight assembly on a drill rig can be used to pound the probe into the ground. This is done in the same manner as driving a split spoon sampler. The drop weight is screwed onto the drive extensions, lifted, and allowed to free fall onto the drive extensions. This process pounds the drive extensions into the ground in a manner similar to the slide hammer.

CAUTION: The hammer drill adapter and slide hammer drive adapters do not attach securely to the extensions drive adapter. These drive adapters only fit or "nest" into the extension drive adapter. Therefore, it is possible that during operation these drive adapters could come out of the extension drive adapter and cause injury.

7. If the target depth of sampling is deeper than 3 ft, then additional 3-ft drive extension sections must be attached to the drive extension already in the ground. To add another drive extension to the GVP, unscrew the drive extension adapter from the drive extension in the ground and slide the 3/16-in. ID Teflon tubing out of the drive extension adapter. Slide a coupling over the 3/8-in. ID Teflon tubing and screw onto the exposed end of the drive extension in the ground. Now, thread the loose end of the 3/16-in. ID Teflon through the next 3-ft drive extension and the drive extension adapter. Screw the new 3-ft drive extension into the coupling on top of the drive extension in the ground. Rescrew the drive extension adapter to the new 3-ft drive extension. Check all exposed joints and couplings and

tighten with pipe wrenches. For the system to work properly and not break, all fittings must be tight. Continue to advance the GVP into the ground as before. Repeat Part 7 of Step 4 until the target depth is reached.

8. Once the GVP has reached the target depth, it must be pulled back toward the ground surface 1 to 3 in. to open the GVP retractable tip and allow soil vapor to flow into the GVP during sampling.

9. After the GVP has been positioned, the soil surface around the outside of the GVP must be backfilled and/or compressed to reduce the influx of ambient air into the subsurface. This is especially critical for tight conditions associated with clayey or wet soils. Where the soil is sandy and loose, organic-free (i.e., high performance liquid chromatography) water can be mixed with the native soils at the surface to create a mud cake. However, overwatering must be avoided so that the water does not flow down the hole. Where a solid surface is present (i.e., asphalt, concrete) modeler's clay or mud made from natural soils and organic-free water can be used to make a surface seal.

   NOTE: If the soils are extremely hard or rocky, the GVP tile probes can be used to make a smaller pilot hole prior to installing the GVP. The tile probe consists of several 3-ft-long sections of 3/8-in. diameter solid, hardened steel probes. The tile base section has a enlarged point welded on one end to reduce drag on the rest of the tile probe. Additional sections of tile extensions can be connected together using couplings similar to the GVP drive extensions. Once a pilot hole is made, the GVP is driven as described in Step 4.

Step 5: Sampling Preparation

Once the GVP is in place, the loose end of the 3/16-in. ID Teflon tubing is attached to the outside of the vacuum box using a hose connector. On the inside of the vacuum, the hose connector is attached to a small section of 3/16-in. ID Teflon tube that is in turn attached to a Tedlar bag. Therefore, samples can be removed from the vacuum box with no loss of volatiles. A vacuum pump is also attached to the vacuum box with 3/16-in. ID Teflon tube so that a vacuum can be applied to the vacuum box. When the vacuum pump is turned on, the vacuum box is evacuated and the negative pressure inside of the vacuum box causes the Tedlar bag to inflate, drawing air out of the ground through the tip of the GVP.

NOTE: If a vacuum pump is not available or breaks down in the field, the Mityvac hand-held pump can be used. Simply attach the 3/16-in. ID Teflon tube from the GVP to the intake port on the front of the Mityvac. The Tedlar bag is then attached to the exhaust port on top of the Mityvac and inflated.

Step 6: Sample Purging

The same approximate volume of soil vapor must be evacuated from each sampling location. In order to accomplish this, close the vacuum box, attach the inlet to vapor probe tubing, turn on the pump, open the inlet valve, and purge the probe live for 30 seconds. This standard purging process removes the dead air inside the GVP and ensures that the same volume of soil vapor will always be purged from each hole prior to sampling regardless of sampling depth, soil porosity, or flux rate of soil vapor. The described approach physically measures the volume of air removed, as opposed to measuring the flow rate of air out of the ground theoretically or calculating flow rates using a flow meter. Based on the references, 1 to 3 L of air is typically recommended for purging. A 1-L volume of air has been chosen as the standard purge volume to reduce the amount of soil vapor disturbed in the subsurface and to provide a soil vapor sample as representative as possible of the actual conditions present. For quality assurance purposes, the same 1-L Tedlar bags will always be dedicated to the purging process.

Step 7: Sample Collection

After purging the GVP, the soil vapor can be analyzed using either portable field instrumentation or collecting a sample of soil vapor in a Tedlar bag. To analyze the soil vapor directly from the Teflon tube, detach the 3/16-in. ID Teflon tube in the GVP from the vacuum box. Next, secure the portable field instrument to the Teflon tube and conduct the analysis as per the instrument SOP or manufacturer's instructions.

To collect a Tedlar bag sample of soil vapor, attach a 0.3-L Tedlar bag to the 3/16-in. ID tube inside of the vacuum box and inflate in the same manner as previously described. The smaller sample size is desired to reduce the amount of mixing/dilution of the soil vapor, minimize disruption of the subsurface, and decrease the overall volume of samples to be potentially stored. The collected soil vapor sample is now ready for analysis.

NOTE: Soil vapor samples in Tedlar bags need to be stored at ambient temperatures and pressures similar to those during sampling if not analyzed immediately. Vapor samples must not be cooled because this might cause segregation of the vapor mixture, condensation of the volatile contaminants, or loosening of the container seals. All vapor samples must be kept in the dark and out of sunlight to reduce the chance of photochemical reactions with or within the Tedlar bag. All stored samples in Tedlar bags must be analyzed within 2 hours of collection to minimize the effects of adsorption, chemical reactions with or within the Tedlar bag, and loss of volatiles.

Step 8: GVP Removal

Once the soil vapor sample has been collected, the probe must be removed from the ground. There are two methods available to do this:

1. Hi-Lift Jack. If the probe can not be removed manually or is in tight (i.e., clayey or wet) or rocky soils, than the Hi-Lift jack should be used to back the probe out of the ground. Slide the slot in the jack base around the drive extension. Make sure that a coupling is on the end of the drive extension so that the Hi-Lift jack will fit under the coupling. After the Hi-Lift jack is in place, move the handle of the Hi-Lift jack down. The Hi-Lift jack will engage the coupling and begin lifting the drive extensions out of the ground.

   Caution: The Hi-Lift jack is a modified truck jack and should not be used for any other purpose other than removing drive extensions.

2. Drill Rig. If the probes are deeper than 6 ft and there is good access to the probe location, then the cathead assembly on a drill rig can be used to back the probe out of the ground.

NOTE: The manufacturer does not recommend using the slide hammer attachment to "hammer" the probe out of the ground. The upward hammering stresses the coupling joints and shears off the threads of the drive extensions. Therefore, the slide hammer attachment to remove the GVP has not been purchased.

Step 9: Decontamination

Between sample locations the internal surfaces of the soil vapor system (i.e., Teflon lines and Tedlar bags) will be decontaminated by purging the system. Adequate purging is accomplished by drawing three volumes of ambient air through the complete sampling system (i.e., drive tip, Teflon tubes, and Tedlar bag). The outer steel pipe and retract-a-tip casing will be reused between probe holes. Decontamination of these pieces is not necessary because the sample (vapor) is not in contact with them, and the shallow (30 in.) depth of this soil-gas survey precludes the likelihood of encountering any contaminated soil. A new gas vapor probe tip and Teflon tubing will be used for each sampling location.

Old tips and used drive extensions will be cleaned at the end of the survey using the following steps:

1. Wash and scrub equipment with nonphosphate detergent
2. Rinse with tap water
3. Rinse with deionized water
4. Air dry all equipment
5. Wrap in aluminum foil or place in clean poly bags, label with date, and write initials of person who performed the cleaning.

Sampling equipment will be completely air dried before the collection of samples. In the unlikely event the soil vapor probe assembly is determined to be radiologically contaminated, it will be double bagged and segregated from other clean waste and subsequently disposed of or decontaminated after consultation with the health physics technician and the project manager.

After removal of the probe assembly (the vapor probe tip may or may not be retrieved), place the Teflon tube and tin in a plastic bag for subsequent cleaning at the end of the project. Install a new tip and Teflon tube to the drive assembly. Check to ensure the extension drive adapter is threaded properly to the drive extension and tighten with appropriate tools.

Materials and equipment known or suspected to be contaminated and for which decontamination or treatment is not feasible shall be properly disposed of. These materials may include disposable clothing, tools, or other equipment, as well as contaminated soil and water from sampling and decontamination activities.

Step 10: Multidepth Sampling

If a deeper sample is required to determine the vertical distribution of contaminants or to generate a three-dimensional profile, a new set of probes can be reinserted into the sample hole and advanced downward to the next target depth as described in Step 4. Once the target depth has been reached, the soil vapor sampling process will be followed as discussed above in Steps 5 through 8.

7. SEMI-PERMANENT MONITORING POINTS

A semipermanent soil vapor location can be made for routine or frequent sampling in one location by using an AMS expendable tip and Teflon umbrella attached to 3/16-in. ID Teflon tubing. The 3/16-in. ID Teflon tubing is threaded through the drive extensions and the Teflon umbrella and expendable tip are inserted into the drive extensions. The expendable tip/Teflon tube are advanced to the target depth as described in Step 4. The drive extensions are then pulled back out of the ground as described in Step 8, leaving the expendable tip/Teflon tubing in place. During removal of the drive extensions, the Teflon umbrella unfolds, preventing soil from collapsing on and around the expendable tip. Soil is backfilled around the Teflon tube to fill in the annulus space formed by the drive extension. Any excess Teflon tubing should be trimmed back. A polyvinyl chloride (PVC) casing may be installed around the Teflon tubing for protection. The open end of the Teflon tubing must be crimped or otherwise sealed between sampling events to eliminate the flux of soil vapor through the Teflon tube. This will allow the subsurface to stabilize and not be continually pumped by changes in barometric changes.

8. QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

A major concern for soil vapor sampling is the comparability of results between sample points. To successfully determine whether observed differences are due to true differences in subsurface contamination, there must be some degree of confidence in the comparability of the data. Data comparability may be evaluated by assessing the diurnal/daily fluctuations in soil vapor concentrations and the effect of small-scale geologic variability by using collocated samples.

Diurnal/Daily Fluctuations. Semipermanent monitoring points must be established within the study area and sampled three times daily (i.e., at the beginning, middle, and the end of the day) if sampling will take longer than one-half day.

Small-Scale Geologic Variability. Colocated samples may be used. The number of samples and their location depends on the geologic variability and size of the site. A minimum of 5% of the total number of samples to be collected during the survey should be planned.

A second concern is the question of how well the soil vapor measurements represent the primary contamination. Because soil vapor sampling is an indirect measure of soil/groundwater contamination, confirmation with analysis of the source matrix (i.e., soil or groundwater) may be considered. Therefore, the emphasis on data bias and accuracy are not as necessary as in other techniques.

Quality Assurance/Quality Control Samples

Replicate samples are analyzed to determine sampling, sampling handling, and analytical precision, and to estimate within and between sample variability, which is crucial to determining when one sample point has a concentration that is significantly different from another. Sample collection replicates are separate samples collected from the same location into separate sample containers in succession. Analysis of sample collection replicates provides an indication of the combined sampling and analytical precision, and should also be compared with analytical replicates such as sample analytical replicates and analytical standard replicates.

Sample analytical replicates are repeat analyses of the same sample by the analyst in succession. Sample analytical replicates are used to estimate the analytical precision for the samples.

Analytical standard replicates are made from certified stock solutions, neat compounds, or compressed gases. The standard concentration and ranges should be chosen to reflect those expected in the samples. The analytical standard replicates provide an estimation of the analytical precision achieved in the field.

A major concern with sample collection replicates is that the quality of samples is not influenced by their order of collection (i.e., the additional purge volume of succeeding samples does not result in sample dilution).

Appendix G
Equipment Decontamination

APPENDIX G

Equipment Decontamination
(ETSOP-47)

APPENDIX G

Contents

ENVIRONMENTAL RESTORATION DEPARTMENT
ENVIRONMENTAL STANDARD OPERATING PROCEDURE
COVER SHEET

INFORMATION ONLY

SOP Number: SOP-11.4 Revision: 0

Title: **STANDARD OPERATING PROCEDURE FOR FIELD DECONTAMINATION OF HEAVY DRILL RIGS AND DRILLING EQUIPMENT**

Prepared by: K. N. Keck Date: 02/26/92
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Reviewed by: J. P. Shea Date: 02/27/92
J. P. Shea, Chairman
ERD Independent Review Committee

Approved by: Lois C. Van Deusen Date: 2/28/92
L. C. VanDeusen, Manager
Site Remediation Group

Approved by: Date: 2/28/92
R. L. Norland, Manager
Buried Waste Program (WAG 7) Group

ENVIRONMENTAL STANDARD OPERATING PROCEDURES MANUAL	TITLE: FIELD DECONTAMINATION OF HEAVY EQUIPMENT, DRILL RIGS, AND DRILLING EQUIPMENT NUMBER: 11.4 ISSUE DATE: 02/28/92

1.0 PURPOSE AND SCOPE

1.1 To provide general instructions for field decontamination of heavy equipment, drill rigs, and drilling equipment used to support environmental investigations. It addresses both radiological and chemical contamination considerations for all such equipment, regardless of whether it is owned or leased by EG&G, other INEL contractors or agencies, or subcontractors.

1.2 The methods generally used are steam cleaning or washing heavy equipment with water under high pressure, and/or scrubbing accessible parts with a non-phosphate detergent and water solution under pressure. Swipe (smear) tests are used to indicate radionuclide presence.

2.0 PROCEDURE

2.1 Drill rigs and ancillary drilling equipment (i.e., drill rods, bits) are decontaminated prior to the start of drilling operations, between drill sites, and upon completion of all drilling activities.

2.2 When drilling operations are suspended (such as on a daily basis) and the tools are removed from the borehole or well, the tools are decontaminated before reinsertion into the borehole, and suitably protected (i.e., sealed bags, plastic sheeting) from accidental contamination by dust or other matter that may originate from the land surface near the wellhead.

2.3 Establish a central decontamination location away from the immediate site. If possible use existing decontamination stations where steam cleaners are available or power and water are available for portable steam cleaners. Such stations must have drains for the disposal of rinse water (when appropriate) and disposal facilities for liquid and solid waste.
Make arrangements with the area landlord for use of the facility prior to mobilizing onsite.

2.4 If a central decontamination facility does not exist, a portable temporary decontamination facility will be used. Spread plastic sheeting (about .04 mil thickness) over a natural or man-made depression to collect wash water generated for appropriate disposal. Large timbers may be used to produce a catch basin by spreading plastic over the timbers and cleaning equipment in the depressed center.

Polyvinyl chloride (PVC) or Hypalon decontamination pads with a built-in sump are commercially available. Material collected in the sump can be pumped into drums for proper disposal.

2.5 Field Decontamination of heavy equipment, drill rigs, and drilling equipment:

a. Material and Equipment Needs:

1. Steam Cleaner
2. Generator (or other appropriate power source)
3. Water
    a. organic-free water for rinse
    b. deionized water for rinse (when appropriate)
    c. uncontaminated tap water (from an approved source) for steam cleaning
4. Wire brushes and/or scraper
5. Nonphosphate detergent (i.e., Microclean)
6. Wastewater collection system (may include):
    a. plastic sheeting
    b. Hypalon portable decontamination system
    c. disposable or cleanable peristaltic pump
    d. containers for waste water disposal (when appropriate)
7. Isopropanol
8. Protective Personal Equipment (PPE) as specified in the Health and Safety Plan.
9. Plastic sheeting for covering equipment after decontamination.

b. Complete the following decontamination procedure:

1. Using wire brushes or scrapers to physically remove any bulk material adhering to the item that requires decontamination. If necessary, use water and a nonphosphate detergent to assist in dislodging and removing material.

2. Steam clean or high pressure wash the item, from top to bottom using a back and forth motion.

Note: Water from the steam cleaner is under high pressure and temperature and is capable of causing burns and scalding. Exercise caution when using the steam cleaner to avoid being burned or physically injured. Avoid contact with the wastewater due to potential exposure to either radiologic or hazardous chemical constituents.

3. Use an appropriate solvent rinse (isopropanol) if persistent contamination is detected or suspected. Inform the analytical laboratory of the type of decontamination solvent used.

4. Collect a swipe sample for immediate radioactive analysis if the item is known to be, or suspected of being, radioactively contaminated (see Steps 6–8).

5. Rinse the item with organic-free water and collect the rinsate for analysis, if an equipment blank is required.

Note: Refer to Sampling and Analysis Plan to determine the need for the collection of a rinsate sample for analysis.

6. Have a qualified Health Physics technician obtain a swipe (100 cm^2) from the equipment for a radiation contamination check.

7. The item is considered clean and suitable for use if there are <20 dpm/100 cm^2 (beta, gamma) or <200 dpm/100 cm^2 above background levels and no detectable alpha.

8. Repeat Steps **4, 5,** and **6** if the results are greater than the above limits. If the limits are still not met, consider using appropriate decontamination solutions specific for radiation contamination or disposing the equipment appropriately and replacing the item.

Note: It is important to control the volume of waste water generated during equipment decontamination because liquids generated must be contained and collected for subsequent disposal.

2.6 The final disposition of rinse water and material dislodged from equipment will be specified in the Sampling and Analysis Plan and the Investigative Derived Waste Plan. The ERP Project Manager, Field Team Leader, Health and Safety Officer, Environmental Coordinator for the facility, and the facility environmental engineer determine appropriate disposal of decontamination wash water. All solvents used during decontamination are collected for appropriate disposal.

3.0 DEFINITIONS

No terms cited in this procedure require special explanation.

4.0 REFERENCES

U.S. DOE, 1989. The Environmental Survey Manual, 2nd edition, Appendix G- Decontamination Guidance, Section G2.4, Sampling Equipment, p. G-6.

NIOSH/OSHA/USCG/EPA, 1985. Decontamination of the Occupational Safety and Health Guidance manual for Hazardous Waste Site Activities, Chapter 10. U.S. Printing Office, October, 1985.

U.S. EPA, 1985. Decontamination Techniques for Mobile Response Equipment Used at Waste Sites (State-of-the-Art Survey), EPA/600/52-85/105.

INFORMATION ONLY

ENVIRONMENTAL RESTORATION DEPARTMENT
ENVIRONMENTAL STANDARD OPERATING PROCEDURE
COVER SHEET

SOP Number: SOP-11.5 Revision: 0

Title: **STANDARD OPERATING PROCEDURE FOR FIELD DECONTAMINATION OF SAMPLING EQUPMENT**

Prepared by: K. N. Keck Date: 02/26/92
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ENVIRONMENTAL STANDARD OPERATING PROCEDURES MANUAL	TITLE: FIELD DECONTAMINATION OF SAMPLING EQUIPMENT NUMBER: 11.5 ISSUE DATE: 02/28/92

1.0 PURPOSE AND SCOPE

To provide general instructions for field decontamination of sampling equipment used to support environmental investigations. Thorough decontamination is required to prevent cross contamination between samples and sampling sites.

2.0 PROCEDURE

2.1 All sampling equipment (i.e. Teflon bailers, split-spoon samplers, funnels, spoons, pans) is decontaminated before sampling activities begin, before moving sampling activities to another location/well, and after sampling activities are completed. If several samples are being collected from a single location, such as with split-spoon sampling at depth, the sampling equipment is thoroughly decontaminated between samples. However, full decontamination of sampling equipment between locations is not required when collecting subsamples that will constitute a single composite sample. For composite samples, the equipment used between subsample collection need only be brushed or wiped off to remove any large chunks of soil adhering to the equipment.

2.2 Establish a central decontamination location away from the immediate sampling site.

2.3 **Material and Equipment Needs:**

- a. Non-phosphate detergent (i.e., Microclean)
- b. Wire brush/bottle brush
- c. Water:
  - a. Organic-free water
  - b. Deionized tap water
  - c. Uncontaminated/potable tap water
- d. Isopropanol
- e. Carboy and/or 55-gal drums (poly) for storage of tap water used in steam cleaning/decontamination, as appropriate
- f. Waste water collection system (may include):
  - a. Plastic sheeting
  - b. Containers for waste water collection (separate containers for water, solids, and solvents)

g. Steam cleaner and generator (optional)

h. Personal protective equipment (PPE) as stated in the Health and Safety Plan

i. Stainless steel pans with lids

j. Maislan wipes

k. Blotter paper

l. Spray bottles

m. Sponges

2.4 Field Decontamination Procedure for Sampling Equipment:

a. Physically remove any bulk material adhering to the item that requires decontamination by using a wire brush or scraper.

Note: Wire brushes should not be used on non-metal equipment.

b. Remove gross contamination with tap water and rinse, using pressurized or gravity flow tap water. Scrub brushes or wire brushes may help in removing material.

c. Wash and scrub the equipment with a non-phosphate detergent and tap water.

d. Rinse thoroughly with tap water. Steam clean the equipment if a steam cleaner is available and the equipment is not heat and steam sensitive.

Note: Steam cleaning is not acceptable if radiological contamination is present, due to the potential for creating airborne contamination problems.

e. Check for adhered soils; use a brush to dislodge any particles.

f. Double rinse with organic-free water.

g. Spray-rinse all surfaces with isopropanol from an approved wash bottle.

h. Collect the isopropanol in a container for appropriate disposal (see Section 2.5). One effective collection technique is to place a large glass or stainless steel funnel below the tools during rinsing. Allow waste to flow into appropriately sized bottles for later disposal. Use a stainless steel mixing bowl as a collection vessel. The bowl is the last item cleaned in the sequence of operations.

i. If a rinsate sample is required for QA, make an additional final rinse of the equipment, using ASTM Type II or HPCL grade water, and collect it in the appropriate sample bottles.

j. If the equipment is known to be or suspected of being radioactively contaminated, have the Health Physics Technician collect a swipe (100 cm^2 smear) sample for immediate radionuclide analysis.

k. The item is considered clean and suitable for use if there are <20 dpm/100 cm^2 (beta, gamma) or <200 dpm/100 cm^2 (beta, gamma) above background levels and no detectable alpha.

l. If the radiological limits are not met, discuss with the Health Physics Technician the possibility of using a special decontamination solution for radionuclides and/or disposing and replacing the item.

m. Allow sampling equipment to completely dry prior to re-use.

n. Wrap and store sampling equipment. Aluminum foil is recommended for equipment used in the sample collection for organic analysis. Use plastic wrap or bags if equipment is used for sample collection intended for inorganic analysis. Attach a label to the wrapping or bag indicating the date of decontamination and the initials of the person who performed the decontamiantion.

2.5 The final disposition of rinse water and material dislodged from equipment will be specified in the Sampling and Analysis Plan and the Investigative Derived Waste Plan. The ERP Project Manager, Field Team Leader, Health Physics Technician and/or Safety Officer, and Environemntal Coordinator for the facility, and the facility engineer determine appropriate disposal to decontaminated wash water. All solvents used during decontamination are collected for appropriate disposal.

3.0 DEFINITIONS

No terms cited in this procedure require special explanation.

4.0 REFERENCES

U.S. DOE, 1989. The Environmental Survey Manual, 2nd edition, Appendix G-Decontamination Guidance, Section G2.4, sampling Equipment, p. G-6.

NIOSH/OSHA/USCG/EPA, 1985. Decontamiantion of the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, Chapter 10. U.S. Printing Office, October, 1985.

U.S. EPA, 1985. Decontamination Techniques for Mobile Response Equipment Used at Waste Sites (State-of-the-Art Survey), EPA/600/52-85/105.

Appendix H
Test Plan for Well Gas Sample Collection

APPENDIX H

Test Plan: Well Gas Sample Collection Using A Packer System

EGG-WM-9837
Revision 0

INFORMATION ONLY

TEST PLAN: WELL GAS SAMPLE COLLECTION USING A PACKER SYSTEM

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Test Plan: Well Gas Sample Collection Using A Packer System

Number EGG-WM-9837
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March 1992

INFORMATION ONLY

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ABSTRACT

The vadose zone within and adjacent to the Radioactive Waste Management Complex contains various levels of volatile organic compounds in a vapor state. The most viable way to determine the concentrations and extent of the vapor plume is to measure soil gases at several vertical depths. A packer system will be tested to develop ability to collect vapors from open wells. The results of the test will be compiled and a standard operating procedure will be written prior to sampling open wells under *Sampling and Analysis Plan for Organic Contamination Characterization (OCC) in the RWMC Vadose Zone, Operable Unit (OU-7-08)*, EGG-WM-9834.

CONTENTS

Test Plan: Well Gas Sample Collection Using A Packer System

1. INTRODUCTION

The vadose zone within and adjacent to the Radioactive Waste Management Complex (RWMC) contains various levels of volatile organic compounds (VOCs) in a vapor state. It has been determined that the most viable way to determine the concentrations and extent of the vapor plume is to measure soil gases at several vertical depths (EG&G Idaho, 1991a). Existing open well 118 will be used to test the packer system to a depth of up to 550 ft.

The tests outlined in this test plan are intended to evaluate the equipment for use in determining concentration profiles and permeability from uncased wells in and around the RWMC. A separate sampling and analysis plan will be prepared for those activities.

These wells vary in diameter, making it necessary to have a flexible sampling system. The packer assembly is comprised of a pipe covered with an inflatable bladder. The packer is lowered into a well and the bladder is expanded with compressed gas (generally nitrogen). Figure 1 presents a schematic of the packer system and reel. The area packed off is purged for a specified amount of time to remove stagnant air. A gas sample is pulled into a Tedlar bag for analysis by gas chromatography (GC).

1.1 Scope of Tests

The first test will be performed to test the influence of the packer and tubing on a tracer gas. The packer will be inflated within a tube with compressed gas and a known concentration of tracer gas will be injected into the tube between the packers. The gas will be pulled through the packers and tubing using a vacuum source until the tracer is collected into the Tedlar bag. The sample in the Tedlar bag will be analyzed and concentrations will be compared to the original tracer concentration. A second test will be performed to test the system by lowering the packer assembly down the well, inflating the packers with compressed gas (not to exceed the manufacturer's maximum recommended pressure that is stamped on the packer), and pulling air samples to land surface. The packer assembly will be lowered to progressively deeper depths to test the system. A third test will be performed to test permeability measurement equipment using the packer assembly. Air will be withdrawn or injected into the packed off interval of the well while measuring flow rates and downhole pressure. Flow rate will be varied to obtain measurable pressure difference. These data will be used to calculate permeability for the interval.

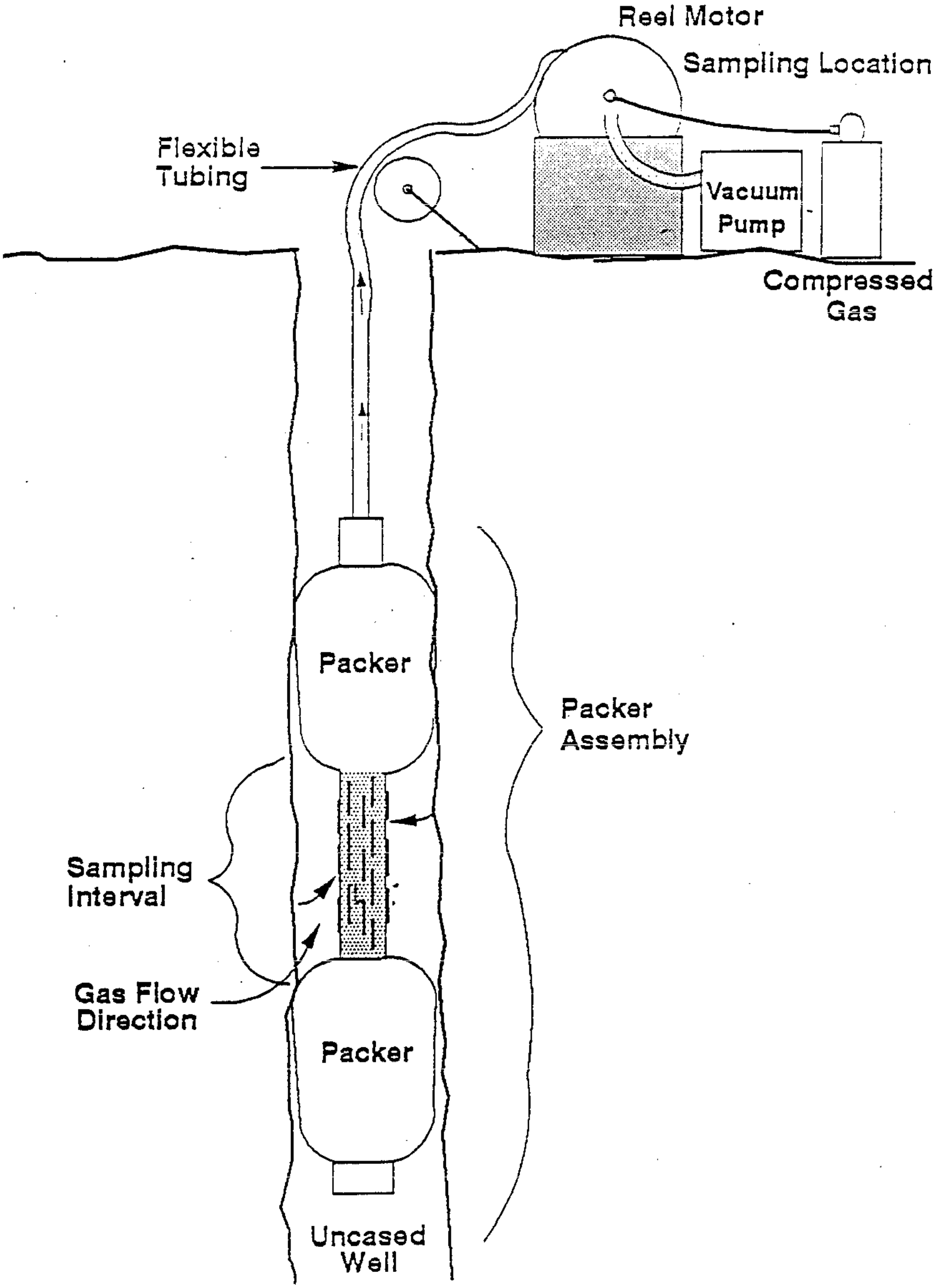


Figure 1. Schematic of the packer system and reel.

1.2 Objective of Tests

The packer system will be tested to ensure (a) the system will provide representative volatile organic analysis samples from the tested interval, (b) pressure transducers and flow regulation equipment are suitable for measurement of permeability for this geologic environment, and (c) the reel system will work for placing the packers. The packer must be able to pack off wells with a wide variety of diameters. The packers must be able to isolate the desired depth intervals and collect representative samples from depths as great as 560 ft. One of the existing test wells (USGS-118) is deep enough to test this requirement.

1.3 Justification

This particular packer system design has not previously been used for either VOC sample collection or permeability tests in the vadose zone at the Idaho National Engineering Laboratory (INEL). The wells must be sampled and tested to meet Environmental Restoration Department (ERD) objectives and regulatory commitments.

2. ORGANIZATION AND RESPONSIBILITIES

2.1 Organizational Structure

An organizational chart is presented as Figure 2. A technician and scientist will be conducting the tests.

2.2 Authority

The authority to conduct the tests comes from Waste Area Group (WAG)-7 management.

2.3 Facility Support Requirements

Well USGS-118, to be used to conduct the packer tests, is outside the RWMC, so no Health Physics (HP) coverage is anticipated. However, all activities conducted around the RWMC will be cleared through RWMC Operations prior to beginning work. A safe work permit will be opened, with signatures from Safety and Industrial Hygiene at the RWMC. The well will be monitored for organic vapors when the well is opened for testing.

2.4 Specific Qualifications

Personnel must have knowledge of the reporting requirements and packer system usage. The operators will follow the guidance provided in the operating instructions for the pneumatic packers (Appendix A). The individuals who will be performing the tests meet these requirements and have extensive experience in field sampling.

2.5 Waste Management

2.5.1 Identification/Generation

A minimal amount of waste will be generated from the decontamination of equipment following testing. This waste will primarily be comprised of rags used to wipe the packers with isopropanol. The waste will not be hazardous according to the Resource, Conservation, and Recovery Act (RCRA). Other potential waste includes paper towels and latex gloves.

2.5.2 Minimization

Waste will be minimized by performing the tests in a minimum number of wells.

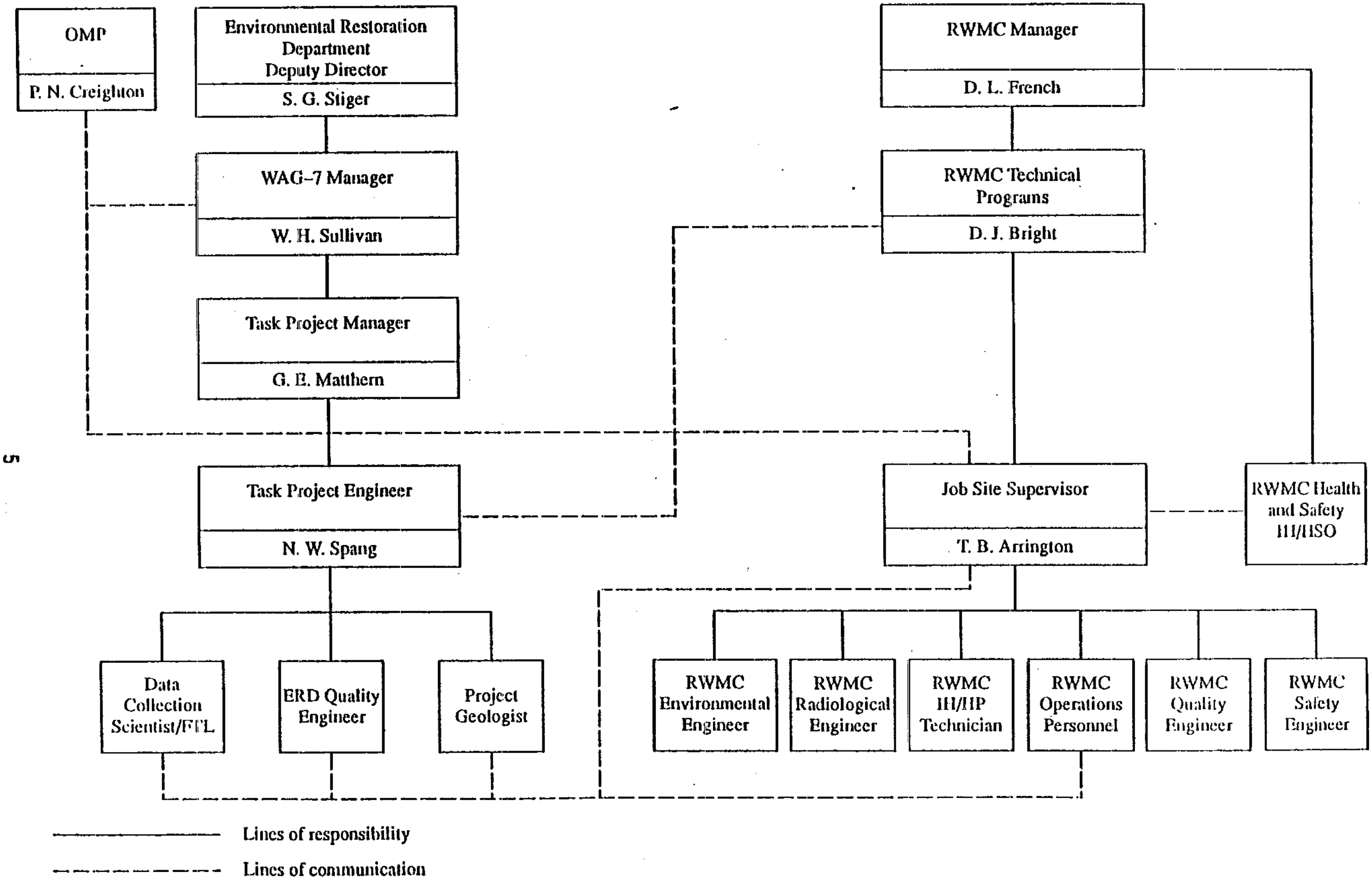


Figure 2. Organizational chart.

2.5.3 Disposal

The process is not anticipated to create any hazardous or radioactive waste, so normal (clean) disposal methods will be used. The waste will be transported to a clean dumpster for disposal as waste generated outside of the RWMC. Waste generated inside the RWMC will be surveyed by a certified HP prior to disposal per requirements of the health and safety plan.

3. DESCRIPTION OF TESTS

The purposes of the packer tests are to ensure representative soil gas samples are collected from open wells at the RWMC and that permeability tests can be performed in the wells. The packers will be located in wells, based on TV logs, in areas where they will be able to adequately pack off an area without significant leakage of air above and below the packed off area. Data will be recorded describing the results of the tests in the sampling logbook. The three tests may be performed at different times. The packer tests consist of the following:

- The system will be placed into tubing and the packer(s) will be inflated with compressed gas. The inflation pressure should not exceed the manufacturer's maximum recommended pressure that is stamped on the packer. A tank of standard gas (55 ppm CCl_4) will be connected to the tubing and gas will be injected adjacent to the interval where vapor is collected while the packers are inflated. The gas sample will be pulled through the tubing to a Tedlar bag sampling device (the Tedlar bag sampling device is labeled *vacuum pump* in Figure 1). The sample will be analyzed by a field GC using the calibration and analysis procedures outlined in EGG-WM-9834 (EG&G Idaho, 1991a) and the RWMC Operating and Maintenance Manual, Section 9.8.1. Samples will be pulled until at least three samples are within ±20% of each other to ensure adequacy of the system and to develop correction factors, if needed.

- The packer system and reel system will be tested at well USGS-118. The procedure will be as follows:

    1. Lower the packer assembly to a depth of approximately 10 ft.

    2. Inflate the packer from land surface using compressed air.

    3. Connect the vacuum pump and gas sampling instruments.

    4. Purge air from the packed off zone using a vacuum pump until the concentrations equilibrate as indicated by the photoionization detector. Concentrations will be considered equilibrated when the PID concentration fluctuates by $\leq$10 ppm/min. Record the flow rate, time, and concentration in the logbook. When the concentration has equilibrated or at times determined by the scientist, collect a sample into the 1-L Tedlar bag for analyses. Transport the Tedlar bag to the GC trailer. No special transportation considerations are required.

    5. Deflate the packer, disconnect the sampling equipment from the reel assembly, and move the packer assembly to land surface to test the reel. If the reel has difficulty in pulling up the packer assembly, do not lower it to the next depth.

6. Lower the packer assembly to progressively deeper depths (approximately 100, 200, 300, 400, and 500 ft. and repeat Steps 1 through 6.

- The permeability measurement system will be tested at several depths in well USGS-118. The anticipated testing depths are 232, 245, and 295 ft. Other depths may be tested, as determined by the scientist, if data indicate that further testing is warranted. Figure 3 presents a schematic of the permeability measurement system. Flow data will be collected by an appropriately sized flow meter, and data will be recorded in the 21x data logger. Pressure will be measured in the well with a transducer attached to the packer assembly. All equipment will be calibrated, maintained, and utilized according to the manufacturer's specifications and recommendations. The procedure will be as follows:

1. Lower the packer assembly to the specified depth.

2. Inflate the packer from land surface using compressed air.

3. Connect the pump and power up the data acquisition system.

4. Record the pressures between packers and at the inlet line going into the packed off zone. Flow rate may be varied to obtain greater pressure differences.

5. Record flow rates and pressures until steady pressure (± 1 lb/in.^2) and flow (± .5 cfm) are established.

6. Shut the valve on the pump and record the pressure until the pressure ceases to change as evidenced by plots of pressure versus time.

7. Deflate the packer, detach the monitoring equipment from the reel, and move the packer assembly to the new level and repeat Steps 1 through 7.

General equipment:

- Bennett sampling pump apparatus (reel) without pump attached

- Packer apparatus with accessories

- Two packers with a 5-ft slotted center attachment, tubing connectors, wire rope, and connectors

- Steel tape, 10 ft minimum

- Permanent marker

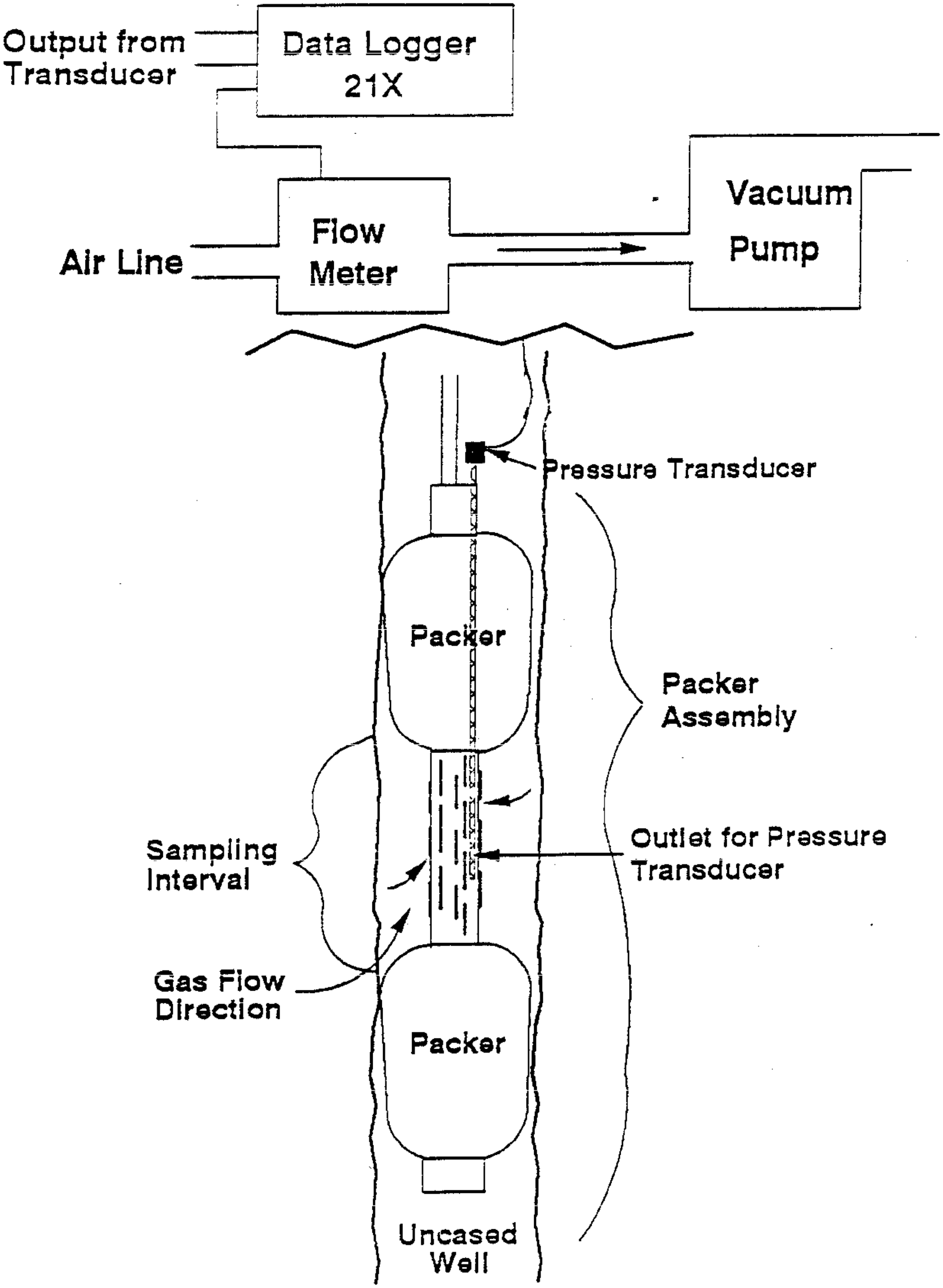


Figure 3. Schematic of permeability measurement system.

- Generator for operating Bennett reel and vacuum pump
- Flow meters (air) 0 to 20 ft^3/min range (estimated)
- Compressed air canister with suitable regulator—need connector to attach to Bennett inflation line tubing
- Compressed air bracket for truck or equipment
- Stopwatch, watch, or timer
- Suitable sampling apparatus, fittings and connectors for Tedlar bag
- Photoionization detector
- Vacuum pump
- Gas chromatograph
- Tedlar bag sampling equipment
- Miscellaneous fittings and tools.

Calibration gas testing equipment:

- Calibration gas
- 4-in. tubing, 5 ft long (approximate size)
- Tedlar bag sampling equipment
- Gas chromatograph.

Permeability testing equipment:

- Transducers with suitable connectors (±15 psi)
- Electrical wiring for transducers
- Variable power supply for transducer (12-volt dc power supply minimum)
- Flow controller/electronic data logger (0 to 20 cfm).

4. IMPLEMENTING TECHNICAL PROCEDURES

4.1 Test Procedures

Refer to Section 3 of this test plan for test procedures.

4.2 Procedure Modification

If any portion of the test procedures require modification, the modification will be documented, along with the reason for modification, in the field team leader's logbook.

4.3 Subcontractors

There will be no subcontractors performing work for this test.

5. SEQUENCE OF ACTIVITIES

5.1 Test Dates

The tests will be performed in the order described in Section 3 of this test plan. Tentative test dates are as follows:

30 March 92	Perform aboveground tests using standard gas. Samples will be analyzed on the field GC immediately following the test.
13 April 92	Perform downhole packer testing at well USGS-118. Again, samples pulled will be analyzed immediately on the field GC.
27 April 92	Prepare draft engineering design file (EDF). The EDF will be finalized when other open wells are sampled using the packer system to account for any further changes to procedure.
28 April 92	Test permeability measurement system.
4 May 92	Prepare draft standard operating procedure (SOP) to conduct sample collection and permeability testing in open wells with packer system.
11 May 92	Submit draft SOP to the ERD Independent Review Committee (EIRC) for review.
27 May 92	EIRC review.
5 June 92	SOP approval by EIRC and WAG-7 manager.
8 June 92	Begin sampling and testing open wells using packer system.
20 July 92	Prepare final draft EDF.

5.2 Coordination with Outside Groups

The packer tests are an integral part of the characterization of the vadose zone. The tests do not require a great deal of coordination between outside groups, other than review by the EIRC. The milestones are as described in Section 5.1.

5.3 Acceptance Criteria

The packer tests will be successful if the samples collected are representative of the concentrations adjacent to the sampled interval, and if permeability tests yield reasonable values compared to field or literature measurements. This will be determined in two ways. First, the aboveground tests using standard gas will verify that the packer system tubing and vacuum pump have the ability to maintain the concentration of the sample over 700 ft of line. Second, samples will be pulled from wells adjacent to ported wells at the same depth as the sample ports during the sampling phase. This test will be performed under a separate sampling and analysis plan for this activity. Samples will be pulled from the ported wells simultaneously. The sample results should be comparable. Calculated permeability measurements will be compared to other field sites and literature values. There is one designated hold point in this procedure if the reel system has difficulty in pulling the packer assembly.

6. PROVISION FOR QUALITY ASSURANCE

6.1 Quality Level Designation

Samples to be analyzed by the field GC will have a quality level of II. Measurements taken will have a quality level IC designation. Data quality objectives for the packer tests are provided in Table 1.

6.2 Applicable Procedures

Quality control (QC) will be performed in accordance with the ERD quality program plan (QPP-149, Section 5.11) (EG&G Idaho, 1991b) except where deviations are authorized by the Project Quality Engineer. Quality assurance (QA) for the field GCs is contained in sampling and analysis plan EGG-WM-9834 (EG&G Idaho, 1991a). Quality assurance for the Microtip will be ensured by adhering to requirements found in the manufacturer's operating and maintenance manual and following the requirements of Section 8.1 of QPP-149 (EG&G Idaho, 1991b).

6.3 Review

Application of QA procedures will be reviewed in accordance with ERD Program Directive (PD) 5.14, "Quality Monitoring and Surveillance" (EG&G Idaho, 1991c).

6.4 Error and Uncertainty

Error associated with sampling the wells will be reduced by ensuring that the VOC concentration going into the sample bag is representative of the true value. Refer to the above procedures for details on this measure. QC corrective actions are outlined in sampling and analysis plan EGG-WM-9834 (EG&G Idaho, 1991a).

Table 1. Data quality objectives for the packer tests.

Measurement	Method	Analytical level	Precision	Accuracy	Detection limit
VOC concentration	Portable GC	II	± 10%	± 20%	1 ppm (CCl_4)
Pressure	XD	I	± 10%	± 20%	.1 psi
Flow rate	Flow meter	I	± 20%	± 40%	.5 L/min

7. SAFETY

Safety will be implemented using health and safety plan EGG-WM-9843 (EG&G Idaho, 1991d).

8. EVALUATION

8.1 Data Evaluation

Evaluators qualified to the requirements in ERD PD 5.12 (EG&G Idaho, 1991c) will evaluate data for acceptance with QA levels specified in Section 6.1 after the tests.

8.2 Deviations and Abnormalities

Deviations from the test plan and/or abnormalities experienced will be recorded in the test plan logbook.

8.3 Peer Review

Two qualified scientists, not involved in the tests, will peer review all documents and test results after completion of the test.

9. REFERENCES

EG&G Idaho, 1991a, *Sampling and Analysis Plan for Organic Contamination (OCC) in the RWMC Vadose Zone, Operable Unit (OU-7-08)*, EGG-WM-9834, Rev. 0, August.

EG&G Idaho, 1991b, *Quality Program Plan for the Environmental Restoration Program*, QPP-149, Rev. 3, November.

EG&G Idaho, 1991c, *Environmental Restoration Program Program Directives Manual*, current issue.

EG&G Idaho, 1991d, *Health and Safety Plan for Organic Contamination Characterization (OCC) in the RWMC Vadose Zone, Operable Unit (OU-7-08)*, EGG-WM-9843, Rev. 0, November.

Appendix A

Tigre Tierra® Pneumatic Packers Operating and Parts Manual

TIGRE TIERRA®

Pneumatic Packers

Operating & Parts Manual

This manual is assigned to

Model No. 36 - 60 - 1.00

Serial No. 3691 - 500, 501

Tigre Tierra® Pneumatic Packers are Manufactured by

AARDVARK
CORPORATION

PACKER OPERATING PROCEDURES

INTRODUCTION

The Tigre Tierra® Packer is a sliding head inflatable packer that expands radially and contracts axially as pneumatic or hydraulic pressure is applied. Steel cable reinforcement within the packer gland element permits uniform expansion over the entire length of the element and allows the outer rubber cover to extrude into borehole irregularities and fractures, creating an effective seal over the entire length of the packer gland element.

Inflation pressure is introduced into the packer through a port on the packer head that is tapped for a standard male tube connector. For inflation tubing, Aardvark recommends 3/16-inch outside diameter (OD) nylon rated at 2,500 psi burst. This tubing allows the user to operate the packer under extreme hydrostatic head conditions not possible with lower pressure-rated tubing.

Four major components make up the Tigre Tierra® Packer (see illustration at back of this booklet):

- Fixed Head
- Center Tube
- Gland Element
- Sliding Head

Both packer heads are tapped with either 1/8-inch NPT or 10-32 threads to permit simultaneous use of multiple packers. The inflation fluid is transmitted through the packer in the annulus between the center tube and the gland element. All packers are shipped with a plug in the sliding head which must be replaced with a tube connector for multiple packer use.

Stamped on the circumference of the fixed head of each packer is the maximum internal pressure that can be applied when the packer is inflated to its maximum diameter. This is the pressure at which maximum gland element expansion occurs. Pressure in excess of this rated pressure voids the warranty.

> ***Note:*** *When a Tigre Tierra® Packer is confined within an open or cased borehole of known diameter, it is possible to exceed the rated free-air pressure without jeopardizing the warranty. See the pressure curves in this booklet or call Aardvark Corporation for details.*
>
> ***Caution:*** *Compressed gasses, such as nitrogen and compressed air, are extremely dangerous, and misuse of these gases can cause serious injury.* ***Follow instructions on the compressed gas bottles.***
>
> *If the packer is tested or inflated above ground, do not test or inflate above 25% of the unconfined rated pressure stamped on the fixed head of the packer.* ***Stay clear of either end of the packer when testing or inflating the packer above ground.***

Gases such as nitrogen and compressed air are extremely dangerous. Misuse of the gases or of the packers that they operate can result in serious injury. Use extreme caution.

Either pneumatic or hydraulic packer inflation is acceptable, although pneumatic inflation is recommended for standard packer systems. Recommended inflation fluids include compressed air, inert gases (such as nitrogen or carbon dioxide) and water.

Exposure to hydrocarbons will damage the packer gland element, and subsequent use will void the Aardvark warranty. Packers are tested and serialized before shipping. The serial number appears on the circumference of the fixed head, next to the maximum internal packer pressure.

Prior to first use, all connections made on site should be tested at low pressure for leaks, and the gauge or regulator on the source of inflation pressure should be calibrated to assure accurate readings. Faulty regulators are a prime case of packer failure.

SINGLE PACKER OPERATION

The fixed head is normally oriented uphole during single packer operation. After connecting the inflation tube to the connector on the fixed packer head, run the packer to the desired depth on drill rods, grout rods or iron pipe. Then connect the inflation tube to the pressure regulator.

With the regulator adjustment lever backed off to zero pressure, open the supply valve on the source of inflation pressure. Slowly and gradually increase pressure to the packer by adjusting the regulator. Final gauge pressure should not exceed the total of rated packer pressure plus hydrostatic pressure above the packer. If you have any questions about inflation pressure, please contact Aardvark Corporation.

When testing or grouting through the packer is completed, release inflation pressure and allow enough time for the gland element to relax to its at-rest diameter. You can tell when the gland element is properly deflated by inserting the inflation tubing into a cup of water. When bubbles cease to appear in the water, the element is deflated. You can then retrieve the packer or reposition it in the borehole for further testing.

If your system includes a pump, be sure to allow extra wire between the sliding head and the pump.

The packer also will function with the sliding head oriented uphole. However, care must be taken when retrieving a packer set in this orientation. In an uncased, irregular borehole, the sliding head may catch on a fracture during retrieval. Continued upward force may cause the gland element to expand mechanically and lodge in the hole.

STRADDLE PACKER OPERATION

For straddle or zone packer operation, the lower packer is oriented with the fixed head uphole. The center tube is capped. Add lengths of perforated steel tubing consistent with desired zone lengths to the fixed head of the lower packer. Connect a length of inflation tubing to the lower packer to join the two packers.

With the sliding head oriented uphole, connect the upper packer to the perforated steel tubing and the inflation tube from the lower packer. Finally, connect inflation tubing to the sliding head of the uphole packer and beginning running the packers into the borehole.

As in single packer applications, gradually increase inflation pressure through the regulator until the gauge stabilizes on a reading that does not exceed rated packer pressure plus hydrostatic head. The zone is now packed off and injection of water or grout can begin. When testing or grouting is completed, release inflation pressure and allow sufficient time for the gland elements to relax to their at-rest diameters. The straddle system can then be retrieved or repositioned for further testing.

Other orientations are possible for each of the packers in a straddle system. These other orientations, however, will result in a packed-off borehole length that is not fixed and could vary according to borehole irregularities.

For instance, the preferred method for testing in open or unstable formations is to orient both packers with the fixed heads uphole. With this orientation, however, the sliding head of the upper packer will move away from the fixed head of the lower packer as packer inflation progresses. Allowance for this movement must be made by using Aardvark's coiled inflation tube to connect the two packers across the zone. Depending on packer model, packer length and borehole size, this vertical movement will be between 2 and 12 inches.

As a result, whether your zone length is defined by distance between packer heads or by distance between gland element seals, actual zone length will be greater than the as-measured zone length if the packers are oriented with both fixed heads uphole.

GLAND ELEMENT
REPLACEMENT

1) Clean up the surface of the packer center tube by removing wrench marks and burrs with emery cloth or file.

   Note: Failure to do this may cause seal damage in Step. 2.

2) Unthread the sliding head from the gland element fitting and remove from the packer.

3) Unthread the gland element from the fixed head and slide it down and off of the center tube.

4) Inspect the O-ring on each packer head and replace if required.

5) Inspect the seals in the sliding head and replace if required.

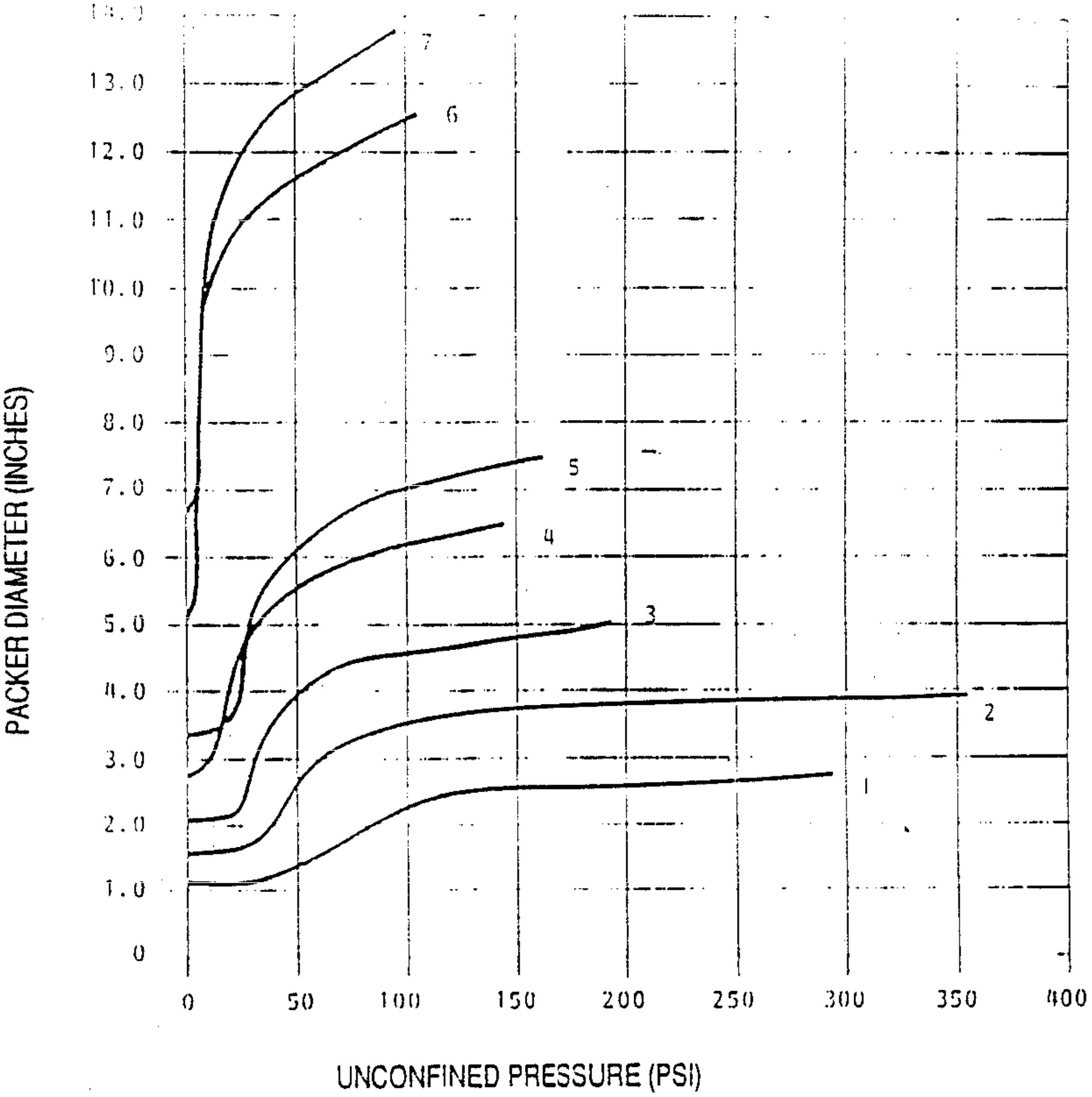
6) Slide the new gland element over the center tube and thread it to the fixed packer head.

7) Push the sliding head on to the center tube and thread it into the gland element.

8) Attach the inflation tube to the fixed head and check for air leaks at connections before running the packer into the borehole.

   ***Caution:** Do not test or inflate above 25% of the unconfined rated pressure stamped on the fixed head of the packer.*

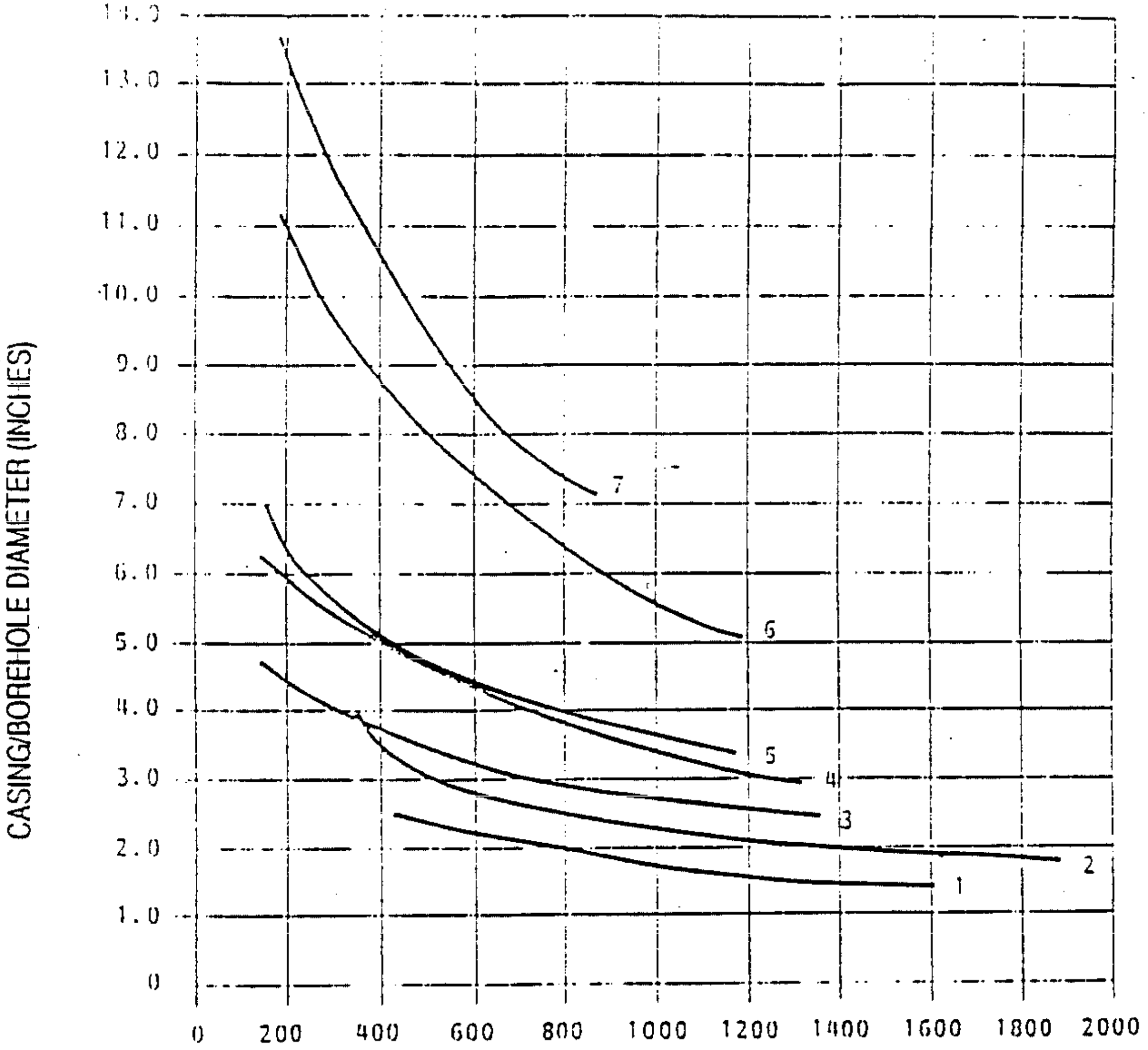
Tigre Tierra®
Pneumatic Packers Pressure Curves



Legend

No.	Model
1	12
2	23B
3	34B
4	36
5	47
6	610
7	713

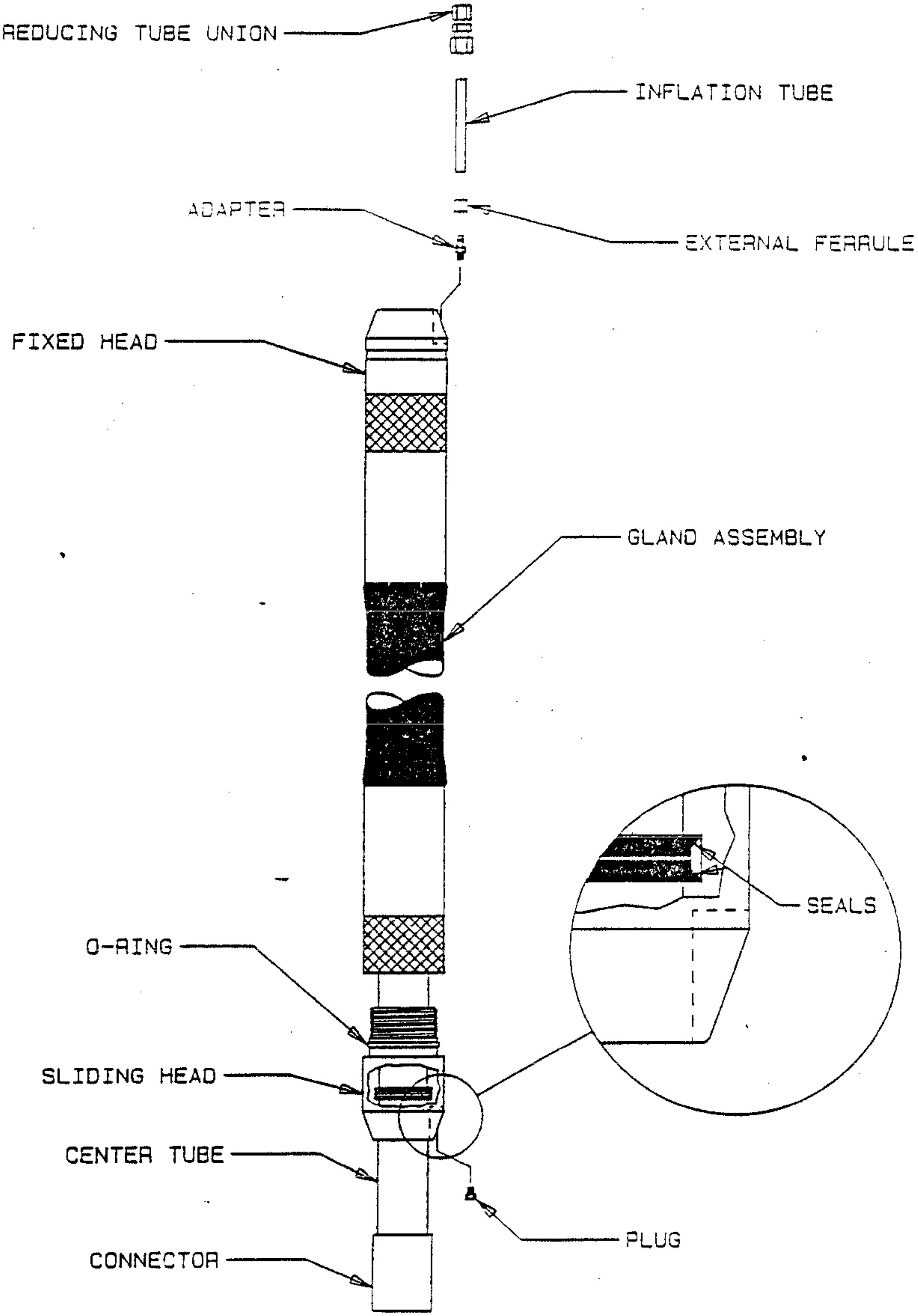
PNEUMATIC PACKERS PRESSURE CURVES



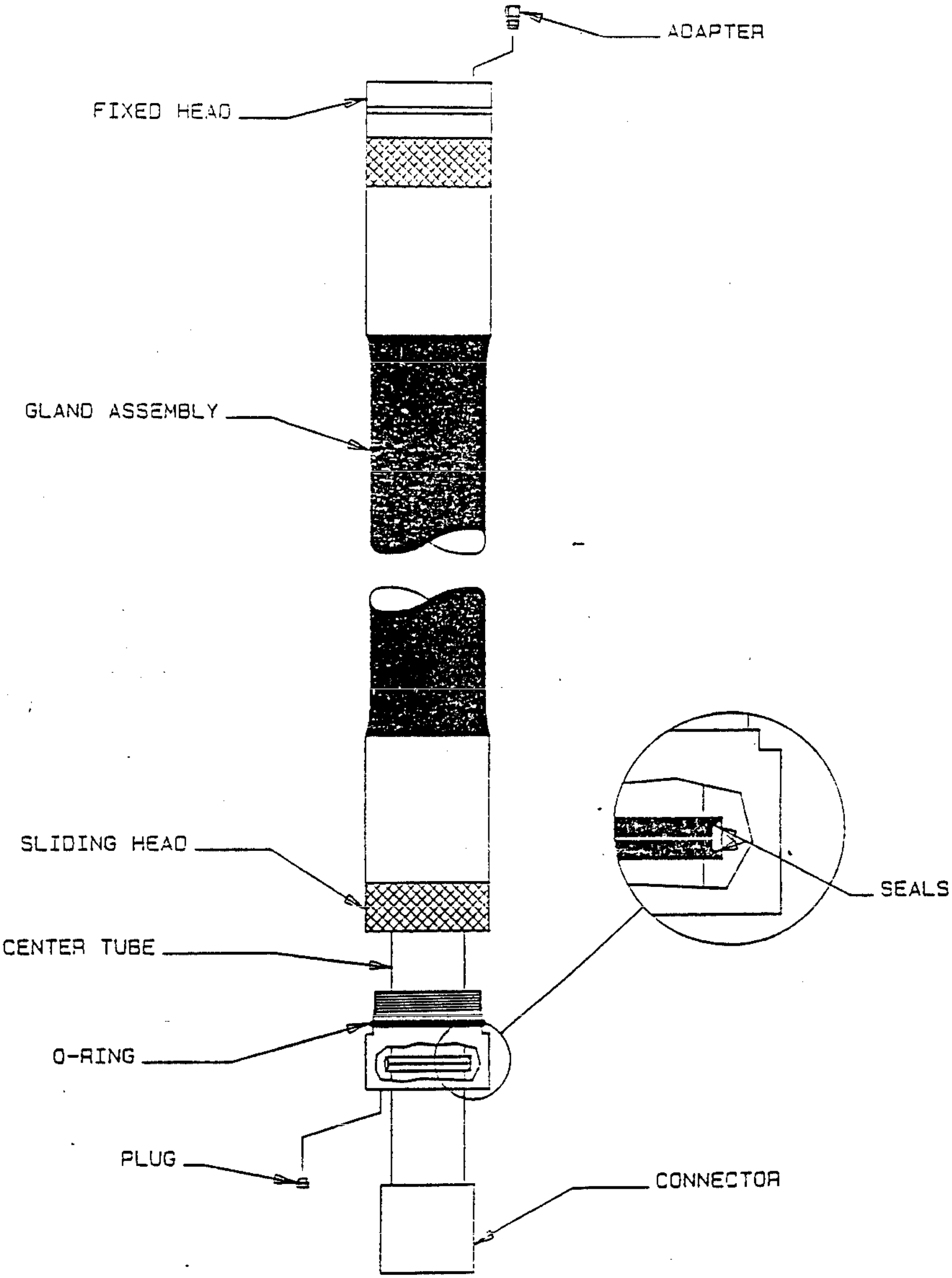
CONFINED PRESSURE (PSI)

LEGEND

No.	MODEL
1	12
2	23B
3	34B
4	36
5	47
6	610
7	713



MODEL 12 THRU 36
PNEUMATIC PACKER ASSEMBLY



MODEL 47 THRU 713
PNEUMATIC PACKER ASSEMBLY

Appendix I
VVE SOP 5.1.2
Gas Port Installation

APPENDIX I

VAPOR PORT INSTALLATION AND SAMPLING

Appendix I

Contents

ENVIRONMENTAL RESTORATION DEPARTMENT INFORMATION ONLY

DOCUMENT APPROVAL COVER SHEET

Document Number: VVE-SOP-5.1.2 Revision: 0

Title: Gas Port Installation Into Existing Boreholes

Prepared by: Shannon Ang Date: 6-25-92

Reviewed by: J P Shea by S. Jenkins Date: 6-26-92
J. P. Shea, Chairman
ERD Independent Review Committee

Approved by: Douglas [illegible] for W. H. Sullivan Date: 6-26-92
W. H. Sullivan, Manager
Comprehensive Rod Unit

Field Changes Authorized by DRR No. ____________________

VVE STANDARD OPERATING PROCEDURES MANUAL	TITLE: GAS PORT INSTALLATION INTO EXISTING BOREHOLES NUMBER: VVE-SOP-5.1.2 ISSUE DATE: 06/25/92

INFORMATION ONLY

1.0 PURPOSE AND SCOPE

This procedure provides instructions for the installation of gas ports into boreholes. The steps given are general and may be used to install ports in both deep and shallow boreholes or wells.

2.0 PROCEDURE

2.1 Prerequisites

There are no specific prerequisites for this procedure.

2.2 QA/QC

There are no specific QA/QC requirements. The Field Team Leader must ensure and document in the Field Team Leader's Logbook that the installation of the ports was conducted according to this procedure. Field changes to this procedure must be approved and appropriately documented per ERP PD 4.1, Document Control.

2.3 Health and Safety Requirements

Activities conducted according to this procedure shall be in compliance with a Safe Work Permit.

2.4 Training

There are no specific training requirements. When the work is done in a contaminated area, appropriate radiological and hazardous waste operator training may be required.

2.5 Precautions/Limitations

Precautions and limitations are covered in sections 2.3 and 2.9.

2.6 Materials and Equipment

3/8 inch or appropriate stainless steel tubing
3/8 inch or appropriate stainless steel connectors
3/8 inch or appropriate stainless steel caps
3/8 inch or appropriate stainless steel quick connect fittings
Duct tape, fiberglass straps, or stainless steel banding
Crimping tools to attach straps and banding (as required)
Sounding device
Measuring tape
Gas vapor ports or portable hand drill to perforate tubing
Hand tools
Tremie pipe to emplace backfill
Slips for tremie pipe
Lifting bail for tremie pipe
Gravel or sand pack material (silica sand)

Bentonite pellets
Cement or bentonite grout
Deionized water
Trash receptacle
Instrumentation Logbook
Daily Activity Logbook

2.7 Calibration/Standardization

Not applicable.

2.8 Transportation

Not applicable.

2.9 Procedure description/installation

1) Decontaminate all tubing, valves, connectors, straps, banding, and other equipment which may have contact with the sampling medium per Environmental Restoration Department Environmental Standard Operating Procedures SOP-11.4 and SOP-11.5. Tubing will be cleaned on the outside and inside.

2) Decontaminate all support structures (e.g., stainless steel casing, pipe) on which the tubing will be attached per Environmental Restoration Department Environmental Standard Operating Procedures SOP-11.4 and SOP-11.5

3) Determine the location of the port in the borehole and the length of port needed to sample the gas permeable zone. The Technical Advisor (TA) and/or the Field Team Leader (FTL) will make the determination prior to installation based upon some combination of information from permeability tests, geophysical logs, TV logs, or lithologic logs.

4) After the length of the port is determined, the FTL (or maintenance shop) will perforate the 3/8 inch tubing using a 1/16 inch drill bit, at a minimum. Holes will be drilled completely through the tubing along the specified length at 1/2-in. to 3-in. intervals, each interval being perpendicular to the previous interval. The Field Team Leader should ensure that the hole diameter in the 3/8-in tubing is compatible with the sand size of the gravel/sand layer.

5) The port will be installed into the borehole simultaneously with the casing or pipe. The bottom end of the tubing should be sealed by folding a section of tubing over on itself, or some similar effective method. If folded, the folded interval should face outward from the casing toward the borehole walls in an upward facing "V". A 2-in. piece of 1/2-in. diameter pipe cut in half lengthwise may be placed over this folded section and strapped to

the support structure.

6) The FTL is responsible to ensure detailed records are maintained in the Field Team Leader's Logbook of the exact location of the perforated intervals relative to the top of casing or pipe and relative to ground surface. This information is crucial during the backfilling operation and any miscalculation could result in the failure of the ports.

7) The tubing should be attached to the support structure along its length with fiberglass straps, stainless steel banding, or other suitable devices. The first strap or band should be at the bottom of the port near the folded section of tubing. The next strap or band should be at or near the top of the perforated section of tubing. The remaining straps or bands may be attached at 5 to 10 ft intervals along the support structure to ground surface. See Figure 1.

8) A two to three foot stickup of tubing should remain above ground surface. It is imperative that the FTL keep track of which tubes correspond with specific depths as it is possible that many tubes will be installed in one borehole. After the installation is complete, the tubes above ground surface should be cut relative to one another in a manner which corresponds to their sampling interval below ground surface. For example, the shortest length of tubing above ground will correspond with the deepest port installation, and so forth. The ports will be labeled "1", "2", and "3", etc. The port labeled as "1" should be the bottommost port in the borehole and the port nearest the ground surface should be the highest number (Figure 2). A record of the related depth for the associated port number should also be documented in the Field Team Leader's Logbook.

Backfilling Procedure:

1) Measure depth of borehole from ground surface.

2) Liquid completion materials must be emplaced with a tremie pipe. Gravel, silica sand, and bentonite may freefall into the borehole; however, it is strongly recommended that tremie be used for all completion materials to prevent bridging.

3) Install backfill around gas ports as illustrated in Figure 1.

4) The thickness of the hydrated bentonite seals at the top and bottom of the permeable zone is dependent upon the geologic conditions in the borehole or the thickness of the cement to be placed above the bentonite seal. Seals should be constructed in order to help prevent collapse of the sand pack, to prevent the infiltration of cement into the sand pack, and to ensure that the permeable zone has been isolated from adjacent permeable zones.

The determination of actual thicknesses will be the responsibility of the FTL or designee.

5) It is recommended that 2 ports be installed in any one borehole per day to avoid the possibility of collapse of the sand layer and to prevent the infiltration of cement into the sand pack. More ports may be installed at the direction of the FTL.

2.10 Data Reduction, Calculations, and Reporting

Not applicable.

3.0 DEFINITIONS

Field Team Leader - The individual responsible for directing field work or a task. Individuals are referred to a Team Leaders, task managers, Project Managers, or work package managers.

Technical Advisor - The individual responsible for advising the field crew on the optimum placement and length of the gas ports.

Field Change - A change originating in the field to an approved controlled document when (a) specific task cannot be performed as written, (b) work directions are unsafe as written, or (c) significant productivity savings can be realized without adverse Environment, Safety, Health, and Quality effects.

4.0 REFERENCES

Environmental Standard Operating Procedures Manual, Field Decontamination of Sampling Equipment, Number 11.5, 2/28/92.

Environmental Standard Operating Procedures Manual, Field Decontamination of Heavy Equipment, Drill Rigs, and Drilling Equipment, Number 11.4, 2/28/92.

Environmental Restoration Program, Program Directive 4.1, Document Control.

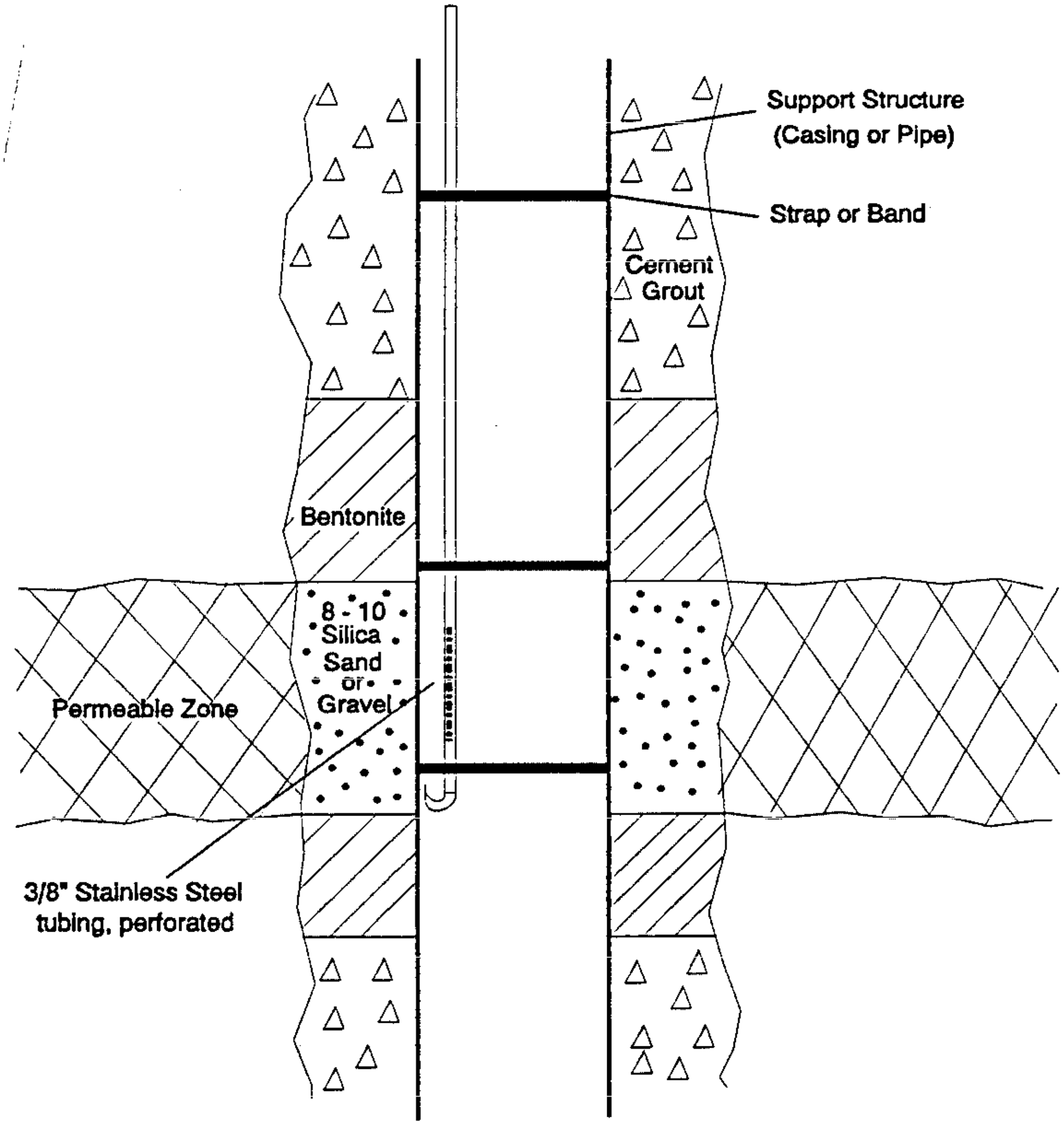


Figure 1. Schematic diagram of a single gas port completion.

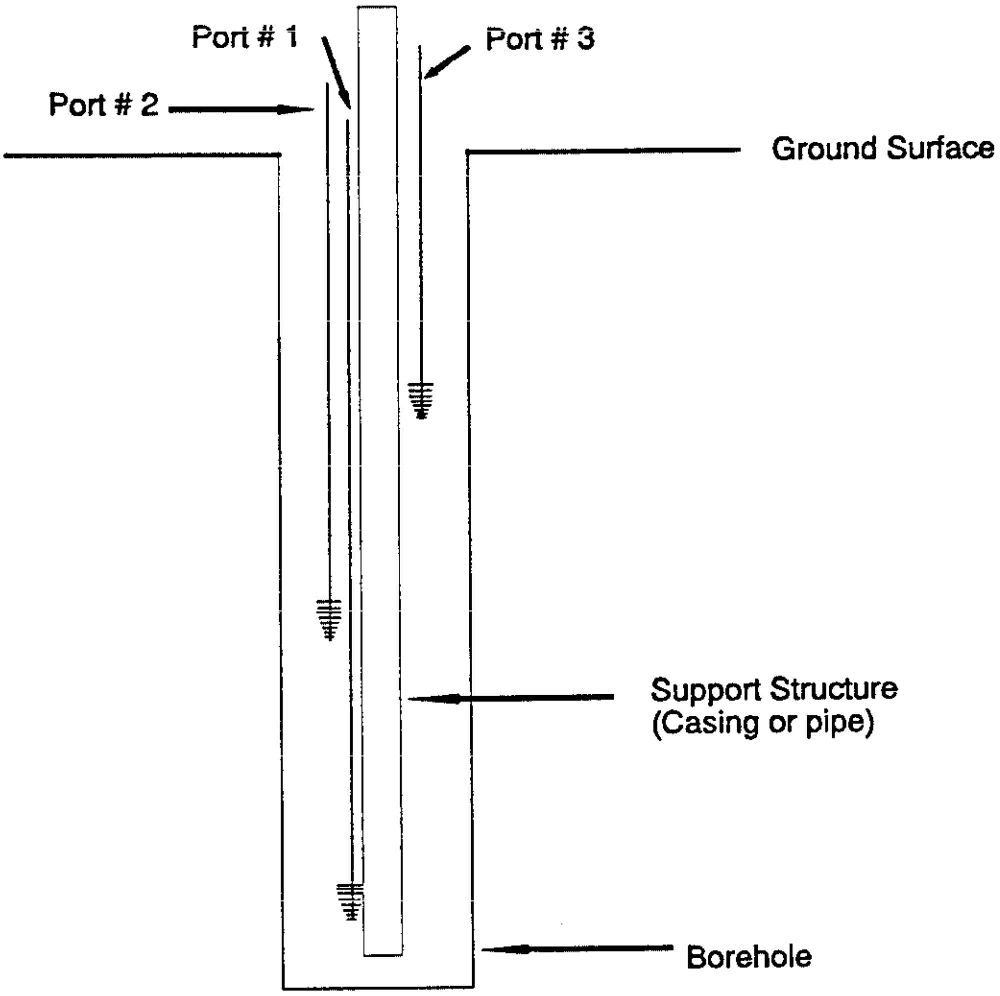


Figure 2. Schematic diagram of surface completion of a borehole instrumented with gas ports. Not to scale.

9.1.9 Sampling Procedures for VVE Sampling Wells

The procedures in this section apply to wells 88-01, 8902D, 74-1, 77-1, 78-4, DO-2, and WWW-1. Sampling frequency is detailed in the VVE Sampling and Analysis Plan. Each well is instrumented with five to 10 sampling measurement ports. Up to five ports/wells will, therefore, be sampled per sampling day. Gas samples from monitoring wells will be collected in 1-L Tedlar bags in a sef-contained battery-powered vacuum kit.

A. Inintial Conditions

1. An adequate supply of prelabeled Tedlar bags are at the VVE site.
2. The vacuum kit is at the site, and the battery in the kit is charged.
3. An adequate supply of gummed labels are on hand.

B. Procedure

1. Ensure that all initial conditions are met.
2. Ensure that the sample port valve (SPV) is closed.
3. Connect the quick disconnect from the sample vacuum box (SVB) line to the sample port.
4. Open the SPV.
5. Turn on the SVB switch.
6. Purge the port line for the prescribed length of time (Refer to EDF-ERP-VVE-070, current revision).
7. Simultaneously turn off the SVB switch and close the valve on the suction line.
8. Open the SVB and install a sample bag.
9. Close the SVB, open the valve on the suction line, and turn on the SVB switch.
10. When the sample bag is three-fourths full, turn off the SVB switch.
11. Allow the sample bag to finish filling.
12. Close the SPV.
13. Open the SVB, close the valve on the sample bag, and tighten the lock screw on the valve.

14. Repeat Steps 1 through 12 for each additional sample.
15. Sample activity informaiton will be recorded int he VVE Operation Logbook.

C. Final Conditions

The vacuum kit is turned off and plugged in to recharge the battery.

Appendix J
Operation of WINPOWER Generator

APPENDIX J

Operation of WINPOWER Electrical Generator

500 11-86

Generating Quality

WINPOWER CORPORATION

Since 1925

Instruction Manual

POWR-PAK®

GASOLINE ELECTRIC PLANT
AIR COOLED – 3600 R.P.M.

EGSA
ELECTRICAL GENERATING SYSTEMS ASSOCIATION

WINPOWER CORPORATION
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PHONE: (515) 792-1301 / CABLE: WINPOWER / TELEX II: 910-520-1567

Printed In U.S.A.

LIMITED WARRANTY

Winpower Corporation hereby warranties for a period of one year as hereinafter stated, the Winpower Alternator or Alternator Set described herein to be free from defects in material and workmanship if properly installed, serviced and operated under normal conditions according to our instructions.

The Winpower Alternator Set is equipped with an engine, for which the engine manufacturer's warranty is attached to the engine manual, and is the only warranty applicable to the engine.

All parts not a part of the engine and/or not manufactured by the engine manufacturer, will be repaired or replaced by Winpower Corporation if found by it, or its authorized service outlet, to be defective in material or workmanship within one year from the purchase date. The equipment added to the engine by Winpower, such as natural or LP gas carburetion, and not furnished by the engine manufacturer, will be replaced by Winpower if found to be defective in material and workmanship within one year from the purchase date.

All transportation charges on parts or units submitted for replacement or repair under this warranty must be borne by the purchaser.

Winpower Corporation hereby disclaims any and all implied warranties, including, but not limited to, warranties of merchantability and fitness for any particular purpose, if and to the extent, but only if and to the extent, that such disclaimer is not forbidden by any applicable law and any implied warranties, including, but not limited to warranties of merchantability and fitness for any particular purpose which Winpower Corporation is so forbidden to disclaim by any applicable law, are warranted one year from date of purchase.

This is the exclusive remedy and liability for consequential, incidental or special damages and/or expenses under any and all warranties are excluded to the extent exclusion is permitted by law.

Form WEA - 7/75

IMPORTANT!

Follow the instructions in the owner's manual specifically when putting this alternator into service. When writing about service or ordering repairs, <u>always show model number and serial number of alternator</u>.

NOTICE

"In order to eliminate a needless waste of time to you, our customer, it is best in case of engine trouble to contact the local dealer or distributor of that particular engine within your area. He can often diagnose a problem and correct the trouble without any difficulty. He also will have a stock of spare parts in case something has to be replaced. ~~All of our engines have National and International distributors or dealers.~~ There should be no trouble with getting our engine serviced within your area.
We are always glad to assist you in obtaining full satisfaction from any engine assembled to a Generator of our manufacture but we know that by contacting the local engine distributor or dealer, a more prompt correction of the engine malady can be achieved."

INTRODUCTION

This manual covers the safety, operating and maintenance instructions for the WINPOWER line of air-cooled generator sets. Included as a part of the package is a parts list and wiring diagram covering the particular model you have purchased. The engine manufacturer's manual is also furnished with the set, and gives the necessary operating and maintenance information for the engine.

GENERAL

The engine generator sets covered by this manual are of the single bearing type. The rotating member of the generator is mounted on a tapered extension of the engine crankshaft.

All sets have been thoroughly tested at the factory. The normal carburetor and engine speed adjustments have been made.

The set should be carefully inspected upon delivery for evidence of possible shipping damage. If damage has occurred, a notation should be made on the freight bill, and you should file a claim, if necessary. If the damage appears to be of a major nature, the set should not be operated until the fault has been corrected.

The model number and serial number of the set must be given when contacting the dealer or the factory.

ELECTRICAL DESCRIPTION

The generators used in the WINPOWER line of air-cooled engine generator sets are revolving armature type.

The static, or electronic excitation system, uses rectifiers to change part of the output of the AC generator to DC for excitation of the field. On most models using static excitation, this system is extended still further by using current feedback through rectifiers in order to obtain increasing field strength with load increase to give better voltage regulation.

OPERATION

ENGINE STARTING

The engine manual should be followed in regards to operation. The engine crankcase must be filled with an oil recommended by the engine manufacturer. The fuel should be regular grade automotive gasoline. When filling the tank, allow for fuel expansion. Never fill tank when engine is running, or while engine is hot.

The carburetor choke should be adjusted as required by temperature conditions. When starting the generator, the operator should assume a stable stance to prevent injury in the event of engine kickback. Pull the start rope with a quick, smooth pull, to crank the engine. Be sure to pull the rope completely through until it clears the starting pulley. After the engine starts, return choke to its normal position. In cold temperatures, it may be necessary to keep the choke in the choke position longer.

HIGH MOISTURE CONDITIONS

The use of electrical equipment under extremely wet conditions should be avoided.

EXHAUST

Generator units must be operated in a well ventilated area to provide adequate cooling air for the engine and proper discharge of exhaust fumes.

STABILITY

Generator units should be placed on a solid level surface for proper engine operation. If there is any indication that the unit may shift during operation, the use of tie downs is recommended.

EXTENSION CORDS

The proper selection of an extension cord is necessary for optimum tool operation. Consult the following chart for proper wire size to carry the required load current. Voltage drops due to the extension cord should not exceed five volts.

WIRE SIZE AWG	MAXIMUM AMPS	VOLTAGE DROP @ MAXIMUM AMPS FOR GIVEN WIRE LENGTHS			
		25'	50'	75'	100'
4	70	.87	1.74	2.60	3.48
6	55	1.08	2.17	3.25	4.35
8	40	1.25	2.51	3.87	5.03
10	30	1.50	3.00	4.50	6.00
12	25	1.98	3.97	5.95	7.96
14	18	2.27	4.55	6.82	9.10
16	13	2.65	5.22	7.84	10.45

MAINTENANCE

ENGINE

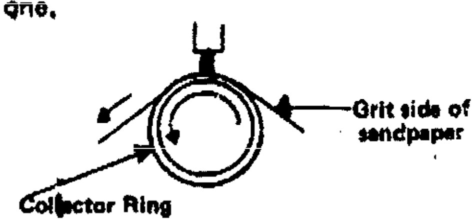
Refer to engine manual.

GENERATOR

Check brush lengths after 500 hours of running and every 100 hours thereafter. If brush length is less than ¼", the brush should be replaced with a new one.

SANDING BRUSHES

It is important that the brushes make good contact with the collector rings. When installing a new set of brushes, they should be sanded in by using 00 sandpaper.



The sandpaper should be pulled in the direction of rotation. When pulled in the opposite direction to start a new stroke, the brush should be raised. Continue the sanding until the brushes are fully seated. Do not use emery cloth.

The collector rings should be cleaned if dirty.

Dirt and the moisture it will hold are detrimental to generators. If dust and dirt accumulate, the generator should be cleaned periodically.

THE FOLLOWING SERVICE PROCEDURES SHOULD BE PERFORMED BY AUTHORIZED WINPOWER SERVICE CENTERS OR OTHER QUALIFIED PERSONNEL.

TESTING FOR OPEN CIRCUITS

TESTING

The most likely place for an open circuit to occur is the shunt field circuit. The shunt field is connected to the rectifier output. One end of the shunt field should be disconnected. An ohmmeter reading should be taken between the disconnected end and the other end to determine continuity. If no reading is obtained, there is an open circuit. Its exact location should then be determined and the open circuit should be repaired. The output leads should be checked for continuity.

RESTORING RESIDUAL MAGNETISM

PROCEDURE

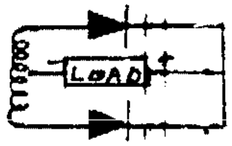
It can be done by applying DC voltage (6–24 volts) across the terminals of the shunt field. Care must be taken that the polarity is correct. Incorrect polarity will destroy the diodes in the rectifier bridge if a limiting resistor is not used.

TESTING RECTIFIERS AND DIODES

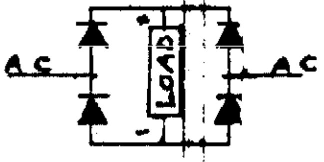
DEFINITIONS

A diode is a single rectifying element represented graphically as shown: 

When a diode is used alone such as in half wave rectification, it can also be called a rectifier. Two diodes are used in full wave rectification as shown:

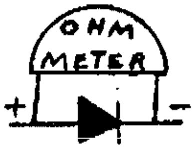


Four diodes are used in a single phase rectifier bridge as shown:



TESTING

An ohmmeter is required for testing a diode or rectifier assembly. It is necessary to remove the leads going to the rectifier for testing it. A single diode will show a very high resistance in one direction and low resistance in the other direction.



Low Reading

Very High Reading

A shorted diode will have a low reading in both directions. An open diode will have a high reading in both directions. Each diode in an assembly can be tested as shown:

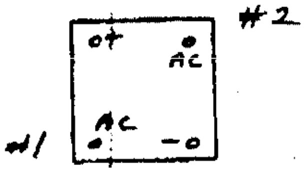
Low Reading

Very High Reading

This reading has to be repeated on every diode.

If the rectifier assembly is a molded assembly, test as follows:

Using a volt-amp-ohm meter (multi meter), check the rectifier assembly in the following sequence:



For purposes of order in checking, consider one AC terminal as #1, the other as #2.

Check Between		Expected Resistance Reading
+ Meter lead on + terminal	— meter lead on AC #1	High
+ Meter lead on + terminal	— meter lead on AC #2	High
+ Meter lead on — terminal	— meter lead on AC #1	Low
+ Meter lead on — terminal	— meter lead on AC #2	Low
+ Meter lead on AC #1	— meter lead on + terminal	Low
+ Meter lead on AC #1	— meter lead on — terminal	High
+ Meter lead on AC #2	— meter lead on + terminal	Low
+ Meter lead on AC #2	— meter lead on — terminal	High

If any readings do not comply with the above chart the rectifier assembly is defective and should be replaced.

ECON-O-MIZER MAGNET ADJUSTMENT INSTRUCTIONS

1. Place Econ-o-mizer switch in off position, start engine.
2. Manually push Econ-o-mizer arm on carburetor up or down to reach an idle speed. Adjust engine idle set screw clockwise to reach 50–60 volts AC at 120 volt receptacle.
3. Stop engine. Adjust magnet up or down so that it just touches the Econ-o-mizer arm. While holding the arm in idle position, tighten magnet into this position.
4. Turn idle set screw one-half turn counterclockwise so that screw does not touch stop on carburetor when arm is against magnet. Adjustment is complete.
5. If Econ-o-mizer will not hold at idle, off load and switch turned on, adjust the magnet farther from the carburetor arm.

TROUBLE SHOOTING CHART

TROUBLE	CAUSE	REMEDY
No output voltage	Loss of residual magnetism.	See instructions for restoring residual magnetism.
	Defective diode in rectifier bridges (see instructions for testing rectifier bridges).	Replace diode or rectifier assembly.
	Poor brush contact (brush can be stuck in holder, worn or spring can be weak).	Free brush if stuck. Replace with new brush if worn. Replace brush spring if weak.
	Open circuit (see instructions for testing of open circuits).	Complete circuit if in external wiring.
	Shorted armature coils in revolving armature unit.	Replace armature.
	Engine speed too low.	Adjust engine speed to correct value.
Low output voltage at no load.	Low engine speed.	Adjust engine speed to correct value.
	Shorted diode (see instructions for testing rectifier bridge)	Replace diode or rectifier assembly.
Voltage o.k. at no load, but drops off rapidly on load application.	Shorted diode in series field bridge (see instructions for testing rectifier bridge).	Replace diode or rectifier assembly.
	Engine speed drops off rapidly.	See engine manual.
High output voltage	Excessive engine speed.	Adjust engine speed to correct value.
Excessive generator heating.	Overload on generator.	Reduce load.
	Clogged ventilating inlets and/or outlets.	Clean inlets and outlets.
Arcing at brushes	Brushes not seated properly.	See instructions for sanding brushes.

MODEL 8015BP/IC

TYPE 1

REF.	DESCRIPTION	PART NO.	QTY.
N.S.	Engine-Briggs & Stratton	EC-11455	1
1	Vibration	W-260	4
2	Carrying Frame	G-7828-2	1
3	Generator Support	S-7213	1
4	Panel Support	I-547	1
5	Field Coil	H-1307-1	1
6	Armature Stud	S-8610-75	1
7	Fan	A-606-1	1
8	End Hood	S-7585	1
9	Field Frame	G-7769	1
10	Bearing	D-4	1
11	Armature	G-7805-2	1
12	Drive End Bell	I-893-1	1
13	Stud	S-7687	4
14	Not Applicable		
15	Lift Eye	S-9566	1
16	Field Frame Assy	G-6039-10	1
17	Field Coil	H-1307-2	1
18	Coil Shield	J-716	4
19	Field Pole	G-6571	2
20	Brush Gear Assy	G-6333-5	1
21	Diode	EE-3100	2
22	Heat Sink	A-791	2
23	Generator Support	S-10192	1
24	Rectifier	EE-2188-1	1
25	Brush Spring	G-3422	3
26	Brush	Y-51	3
27	Studs	S-7687	4
28	Diode Reverse Polarity	EE-3101	2
29	Receptacle L5-20R	EE-1370	2
30	Circuit Breaker 20 A	EE-1885-2	4
31	Not Applicable		
32	Duplex Receptacle 5-20R	EE-323-10	2
33	Panel Box	S-10110-4	1
34	Panel Top	S-10193	1
35	Receptacle 6-50R	EE-399	2
36	Brush Ring	J-558	1
37	Circuit Breaker 30A	EE-2809-5	2
38-	Circuit Breaker 40A	EE-2809-7	1
39	Back Plate	S-10195	1
40	Receptacle L6-30R	EE-1373	2
41	Panel Side	S-10194-3	1
N.S.	Panel Side	S-10194-4	1
N.S.	Fuel Tank	T-75	1

Wiring Diagram IF-5552
Parts Drawing IE-11794

PL- 2483

OWNER'S SERVICE RECORD

CONSULT ENGINE MANUAL FOR SUGGESTED MAINTENANCE AND SERVICE INTERVALS

CONSULT GENERATOR SET OWNER'S MANUAL FOR GENERATOR SERVICE AND MAINTENANCE

	DATE											
ENGINE	Lube Oil											
	Lube Oil Filter											
	Air Cleaner											
	Exhaust System											
	Fuel Filter											
	Lubricate Gov. Link											
	Ignition Tune-Up											
	Battery											
	Cooling Air Intake											
	Cooling Air Discharge											
GENERATOR	Brushes											
	Air Intake											
	Air Discharge											

GENERATOR SET:

Model No. ____________ Type ______

Serial No. ____________

Purchased From ____________

Placed in Service ____________

ENGINE:

Model ____________

Serial No. ____________

Appendix K
Operation of Data Acquisition System

APPENDIX K

Operation of Data Aquisition System

CR10 MEASUREMENT AND CONTROL MODULE

OVERVIEW

REVISION: 6/91

CR10 MEASUREMENT AND CONTROL MODULE

OVERVIEW

TABLE OF CONTENTS

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CR10 MEASUREMENT AND CONTROL MODULE OVERVIEW

Campbell Scientific Inc. provides three documents to aid in understanding and operating the CR10:

1. *This Overview*
2. *The CR10 Operator's Manual*
3. *The CR10 Prompt Sheet*

This Overview introduces the concepts required to take advantage of the CR10's capabilities. Hands-on programming examples start in Section OV5. Working with a CR10 will help the learning process, so don't just read the examples, do them. If you want to start this minute, go ahead and try the examples, then come back and read the rest of the Overview.

The sections of the Operator's Manual which should be read to complete a basic understanding of the CR10 operation are the Programming Sections 1-3, the portions of the data retrieval Sections 4 and 5 appropriate to the method(s) you are using (see OV6), and Section 14 which covers installation and maintenance.

Section 6 covers details of serial communications. Sections 7 and 8 contain programming examples. Sections 9-12 have detailed descriptions of each programming instruction, and Section 13 goes into detail on the CR10 measurement procedures.

The Prompt Sheet is an abbreviated description of the programming instructions. Once familiar with the CR10, it is possible to program it using only the Prompt Sheet as a reference, consulting the manual if further detail is needed.

Read the Selected Operating Details and Cautionary Notes at the front of the Manual before using the CR10.

OV1. PHYSICAL DESCRIPTION

The CR10 is a fully programmable datalogger/controller in a small, rugged, sealed module. Programming is very similar to Campbell Scientific's 21X and CR7 dataloggers. Some fundamental physical differences are listed below.

- The CR10 does not have an integral keyboard/display. The user accesses the CR10 with the portable CR10KD Keyboard Display or with a computer or terminal (Section OV2).
- The CR10 does not have an integral terminal strip. A removable wiring panel, the CR10WP (Figure OV1.1-1) performs this function and attaches to the two D-type connectors located at the end of the module.
- The power supply is external to the CR10. This gives the user a wide range of options (Section 14) for powering the CR10.

OV1.1 WIRING PANEL - MODEL CR10WP

The CR10WP Wiring Panel and CR10 datalogger make electrical contact through the two D-type connectors at the (left) end of the CR10.

The Wiring Panel contains a 9-pin Serial I/O port used when communicating with the datalogger and provides terminals for connecting sensor, control, and power leads to the CR10. It also provides transient protection and reverse polarity protection. Figure OV1.1-2 shows the panel and the instructions used to access the various terminals.

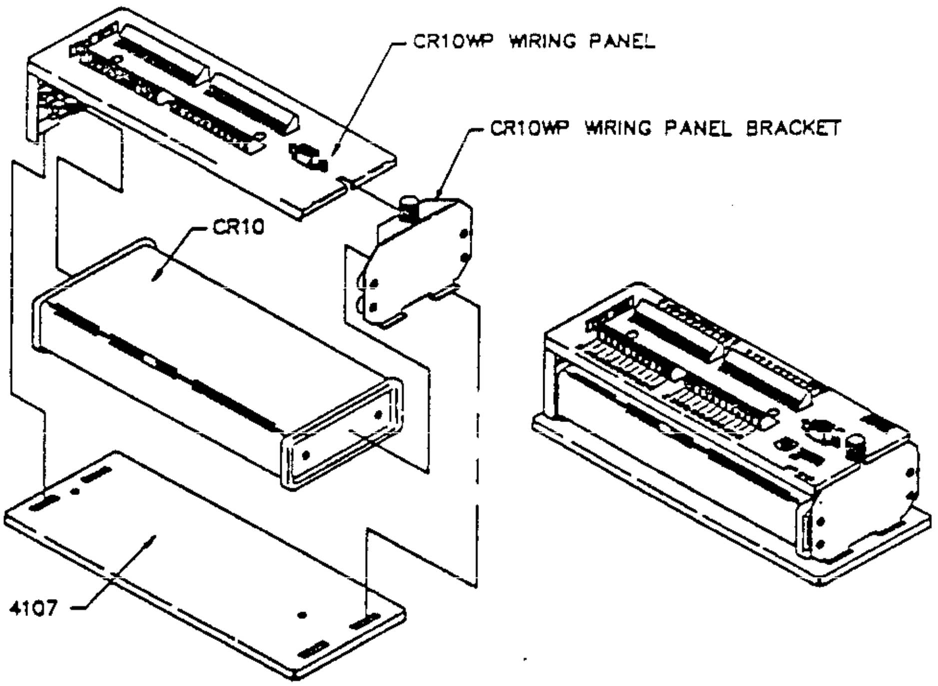


FIGURE OV1.1-1. CR10 and Wiring Panel

OV1.1.1 ANALOG INPUTS

The terminals labeled 1H to 6L are analog inputs. These numbers refer to the high and low inputs to the differential channels 1 through 6. In a differential measurement, the voltage on the H input is measured with respect to the voltage on the L input. When making single-ended measurements, either the H or L input may be used as an independent channel to measure voltage with respect to the CR10 analog ground (AG). The single-ended channels are numbered sequentially starting with 1H; e.g., the H and L sides of differential channel 1 are single-ended channels 1 and 2; the H and L sides of differential channel 2 are single-ended channels 3 and 4, etc. The single-ended channel numbers do NOT appear on the panel.

OV1.1.2 SWITCHED EXCITATION OUTPUTS

The terminals labeled E1, E2, and E3 are precision, switched excitation outputs used to supply programmable excitation voltages for resistive bridge measurements. DC or AC excitation at voltages between -2500 mV and +2500 mV are user programmable (Section 9).

OV1.1.3 PULSE INPUTS

The terminals labeled P1 and P2 are the pulse counter inputs for the CR10. They are programmable for switch closure, high frequency pulse or low level AC (Section 9, Instruction 3).

OV1.1.4 DIGITAL I/O PORTS

Terminals C1 through C8 are digital Input/Output ports. On power-up they are configured as input ports, commonly used for reading the status of an external signal. High and low conditions are: 3V < high < 5.5V; -0.5V < low < 0.8V.

Configured as outputs the ports allow on/off control of external devices. A port can be set high (5V± 0.1V), set low (<0.1V), toggled or pulsed (Sections 3, 8.3, and 12).

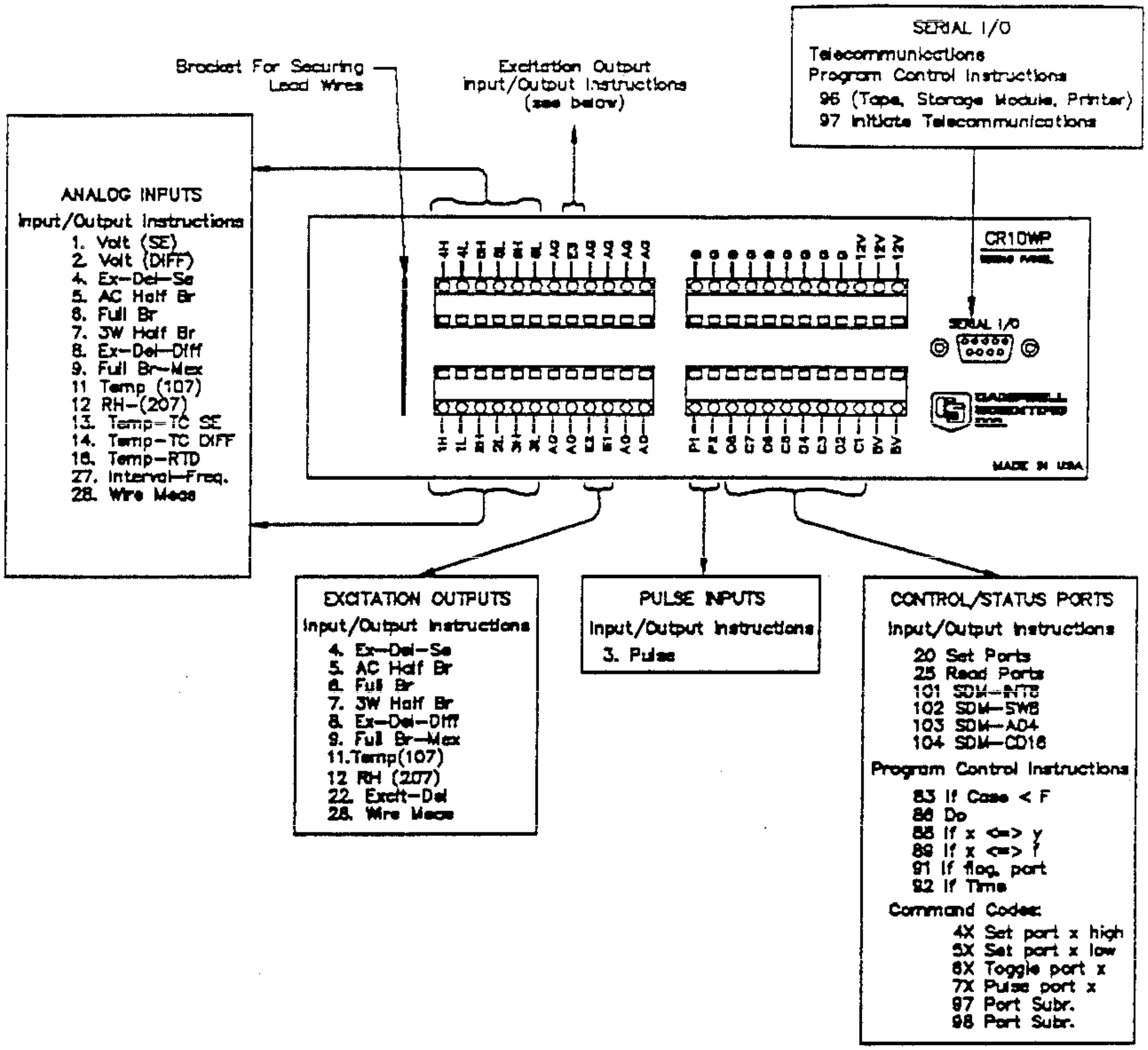


FIGURE OV1.1-2. CR10 Wiring Panel/Instruction Access

OV1.1.5 ANALOG GROUND (AG)

The AG terminals are analog grounds, used as the reference for single-ended measurements and excitation return.

OV1.1.6 12V AND POWER GROUND (G) TERMINALS

The 12V and power ground (G) terminals are used to supply 12V DC power to the datalogger. The extra 12V and G terminals can be used to connect other devices requiring 12V power.

The G terminals are also used to tie cable shields to ground, and to provide a ground reference for pulse counters and binary inputs. For protection against transient voltage spikes, power ground should be connected to a good earth ground (Section 14.3.1).

OV1.1.7 5V OUTPUTS

The two 5V (±0.2%) outputs are commonly used to power peripherals such as the QD1 Incremental Encoder Interface, AVW1 or AVW4 Vibrating Wire Interface.

The 5V outputs are common with pin 1 on the 9 pin serial connector; 200 mV is the maximum combined output.

OV1.1.8 SERIAL I/O

The 9 pin serial I/O port contains lines for serial communication between the CR10 and external devices such as computers, printers, Storage Modules, etc. **This port does NOT have the same configuration as the 9 pin serial ports currently used on many personal computers.** It has a 5VDC power line which is used to power peripherals such as the SM192 or SM716 Storage Module or the DC112 Phone Modem. The same 5VDC supply is used for the 5V outputs on the lower terminal strip. Section 6 contains technical details on serial communication.

OV1.2 CONNECTING POWER TO THE CR10

The CR10 can be powered by any 12VDC source. First connect the positive lead from the power supply to one of the 12V terminals and then connect the negative lead to one of the power ground (G) terminals. The Wiring Panel power connection is reverse polarity protected. See Section 14 for details on power supply connections.

CAUTION: The metal surfaces of the CR10, CR10WP Wiring Panel, and CR10KD Keyboard Display are at the same potential as power ground. To avoid shorting 12 volts to ground, connect the 12 volt lead first, then connect the ground lead.

OV2. MEMORY AND PROGRAMMING CONCEPTS

The CR10 must be programmed before it will make any measurements. A program consists of a group of instructions entered into a **program table.** The program table is given an **execution interval** which determines how frequently that table is executed. When the table is executed, the instructions are executed in sequence from beginning to end. After executing the table, the CR10 waits the remainder of the execution interval and then executes the table again starting at the beginning.

The interval at which the table is executed generally determines the interval at which the sensors are measured. The interval at which data are stored is separate from how often the table is executed, and may range from samples every execution interval to processed summaries output hourly, daily, or on longer or irregular intervals.

Figure OV2.1-1 represents the measurement, processing, and data storage sequence, and the types of instructions used to accomplish these tasks.

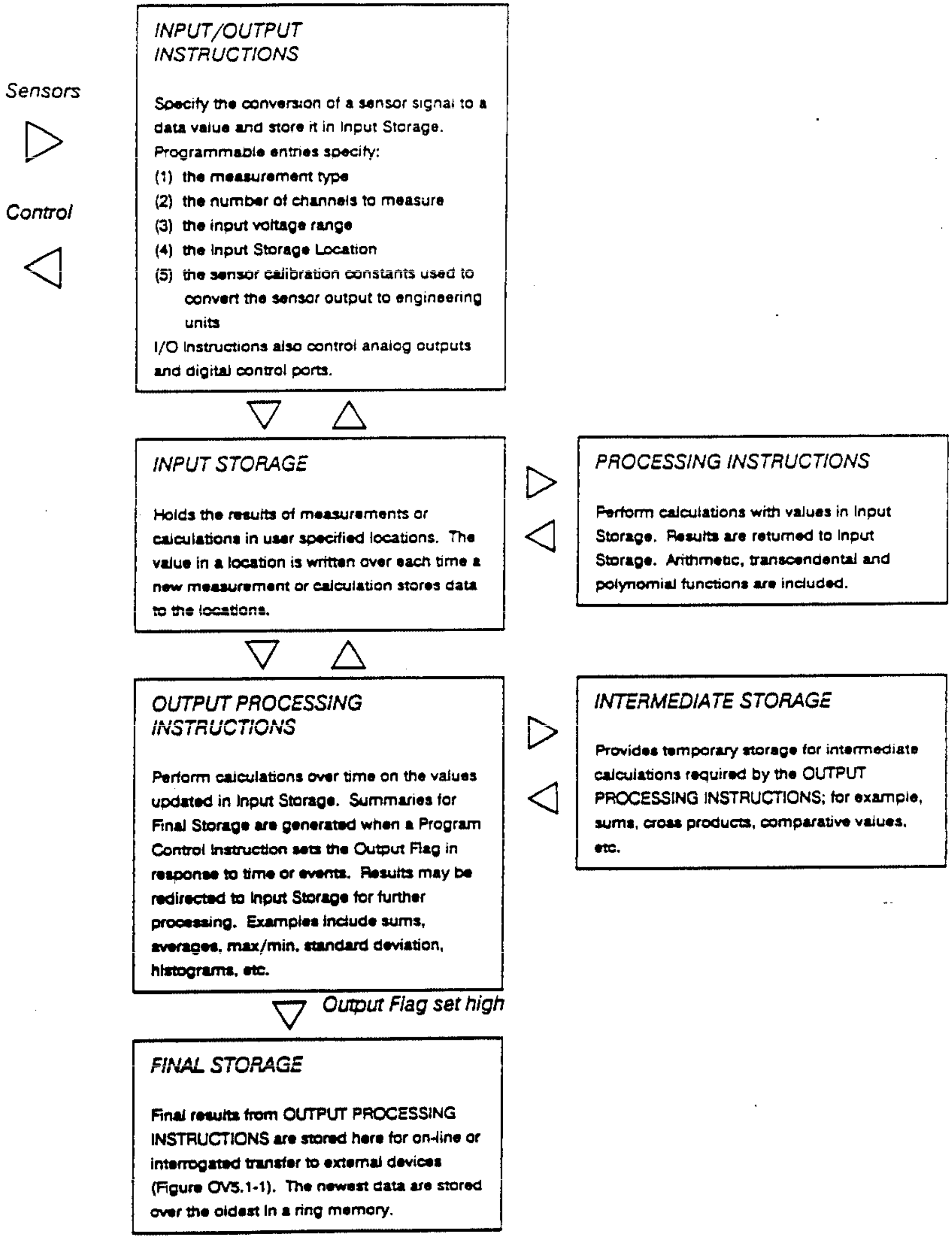
OV2.1 INTERNAL MEMORY

The CR10 has 64K bytes of Random Access Memory (RAM), divided into five areas. The use of the Input, Intermediate, and Final Storage in the measurement and data processing sequence is shown in Figure OV2.1-1. While the total size of these three areas remains constant, memory may be reallocated between the areas to accommodate different measurement and processing needs (*A Mode, Section 1.5). The size of the 2 additional memory areas, system and program, are fixed. The five areas of RAM are:

1. **Input Storage** - Input Storage holds the results of measurements or calculations. The *6 Mode is used to view Input Storage locations for checking current sensor readings or calculated values. Input Storage defaults to 28 locations. Additional locations can be assigned using the *A Mode (Section 1.5).

2. **Intermediate Storage** - Certain Processing Instructions and most of the Output Processing Instructions maintain intermediate results in Intermediate Storage. Intermediate storage is automatically accessed by the instructions and cannot be accessed by the user. The default allocation is 64 locations. The number of locations can be changed using the *A Mode.

3. **Final Storage** - Final processed values are stored here for transfer to printer, tape, solid state Storage Module or for retrieval via telecommunication links. Values are stored in Final Storage only by the Output Processing Instructions and only when the Output Flag is set in the users program. Approximately 29,900 locations are allocated to Final Storage on power up. This number is reduced if Input or Intermediate Storage is increased.



INPUT/OUTPUT INSTRUCTIONS

Specify the conversion of a sensor signal to a data value and store it in Input Storage. Programmable entries specify:

(1) the measurement type
(2) the number of channels to measure
(3) the input voltage range
(4) the Input Storage Location
(5) the sensor calibration constants used to convert the sensor output to engineering units

I/O Instructions also control analog outputs and digital control ports.

INPUT STORAGE

Holds the results of measurements or calculations in user specified locations. The value in a location is written over each time a new measurement or calculation stores data to the locations.

PROCESSING INSTRUCTIONS

Perform calculations with values in Input Storage. Results are returned to Input Storage. Arithmetic, transcendental and polynomial functions are included.

OUTPUT PROCESSING INSTRUCTIONS

Perform calculations over time on the values updated in Input Storage. Summaries for Final Storage are generated when a Program Control Instruction sets the Output Flag in response to time or events. Results may be redirected to Input Storage for further processing. Examples include sums, averages, max/min, standard deviation, histograms, etc.

INTERMEDIATE STORAGE

Provides temporary storage for intermediate calculations required by the OUTPUT PROCESSING INSTRUCTIONS; for example, sums, cross products, comparative values, etc.

FINAL STORAGE

Final results from OUTPUT PROCESSING INSTRUCTIONS are stored here for on-line or interrogated transfer to external devices (Figure OV5.1-1). The newest data are stored over the oldest in a ring memory.

FIGURE OV2.1-1. Instruction Types and Storage Areas

4. **System Memory** - used for overhead tasks such as compiling programs, transferring data etc. The user cannot access this memory.

5. **Program Memory** - available for user programs entered in program tables 1 and 2, and Subroutine Table 3.

OV2.2 CR10 INSTRUCTION TYPES

Figure OV2.1-1 illustrates the use of three different instruction types which act on data. The fourth type, Program Control, is used to control output times and vary program execution. Instructions are identified by numbers.

1. **INPUT/OUTPUT INSTRUCTIONS** (1-28, 101-104, Section 9) control the terminal strip inputs and outputs (the sensor is the source, Figure OV1.1-2), storing the results in Input Storage (destination). Multiplier and offset parameters allow conversion of linear signals into engineering units. The Digital I/O Ports are also addressed with I/O Instructions.

2. **PROCESSING INSTRUCTIONS** (30-66, Section 10) perform numerical operations on values located in Input Storage (source) and store the results back in Input Storage (destination). These instructions can be used to develop high level algorithms to process measurements prior to Output Processing.

3. **OUTPUT PROCESSING INSTRUCTIONS** (69-82, Section 11) are the only instructions which store data in Final Storage (destination). Input Storage (source) values are processed over time to obtain averages, maxima, minima, etc. There are two types of processing done by Output Instructions: **Intermediate** and **Final**.

   Intermediate processing normally takes place each time the instruction is executed. For example, when the Average Instruction is executed, it adds the values from the input locations being averaged to running totals in Intermediate Storage. It also keeps track of the number of samples.

   Final processing occurs only when the Output Flag is high. The Output Processing Instructions check the Output Flag. If the flag is high, final values are calculated and output. With the Average, the totals are divided by the number of samples and the resulting averages sent to Final Storage. Intermediate locations are zeroed and the process starts over. *The Output Flag, Flag 0, is set high by a Program Control Instruction which must precede the Output Processing Instructions in the user entered program.*

4. **PROGRAM CONTROL INSTRUCTIONS** (83-98, Section 12) are used for logic decisions and conditional statements. They can set flags, compare values or times, execute loops, call subroutines, conditionally execute portions of the program, etc.

OV2.3 PROGRAM TABLES, EXECUTION INTERVAL AND OUTPUT INTERVALS

Programs are entered in Tables 1 and 2. Subroutines, called from Tables 1 and 2, are entered in Subroutine Table 3. The size of each table is flexible, limited only by the total amount of program memory. If Table 1 is the only table programmed, the entire program memory is available for Table 1.

Table 1 and Table 2 have independent execution intervals, entered in units of seconds with an allowable range of 1/64 to 8191 seconds. Subroutine Table 3 has no execution interval; subroutines are only executed when called from Table 1 or 2.

OV2.3.1 THE EXECUTION INTERVAL

The execution interval specifies how often the program in the table is executed, which is usually determined by how often the sensors are to be measured. *Unless two different measurement rates are needed, use only one table.* A program table is executed sequentially starting with the first instruction in the table and proceeding to the end of the table.

Table 1. Execute every x sec. $0.0156 \leq x \leq 8191$	Table 2. Execute every y sec. $0.0156 \leq y \leq 8191$	Table 3. Subroutines
Instructions are executed sequentially in the order they are entered in the table. One complete pass through the table is made each execution interval unless program control instructions are used to loop or branch execution.	*Table 2 is used if there is a need to measure and process data on a separate interval from that in Table 1.*	*A subroutine is executed only when called from Table 1 or 2.*
Normal Order: MEASURE PROCESS CHECK OUTPUT COND. OUTPUT PROCESSING		Subroutine Label Instructions End
		Subroutine Label Instructions . End
		Subroutine Label Instructions End

FIGURE OV2.3-1. **Program and Subroutine Tables**

Each instruction in the table requires a finite time to execute. If the execution interval is less than the time required to process the table, an execution interval overrun occurs; the CR10 finishes processing the table and waits for the next execution interval before initiating the table. When an overrun occurs, decimal points are shown on either side of the G on the display in the LOG mode (*0). Overruns and table priority are discussed in Section 1.1.

OV2.3.2. THE OUTPUT INTERVAL

The interval at which output occurs is independent from the execution interval, other than the fact that it must occur when the table is executed (e.g., a table cannot have a 10 minute execution interval and output every 15 minutes).

A single program table can have many different output intervals and conditions, each with a unique data set (Output Array). Program Control Instructions are used to set the Output Flag. The Output Processing Instructions which follow the instruction setting the Output Flag determine the data output and its sequence. Each additional Output Array is created by another Program Control Instruction checking a output condition, followed by Output Processing Instructions defining the data set to output.

OV3. COMMUNICATING WITH THE CR10

An external device must be connected to the CR10's Serial I/O port to communicate with the CR10. This may be either Campbell Scientific's portable CR10KD Keyboard Display or a computer/terminal.

The CR10KD is powered by the CR10 and connects directly to the serial port via the SC12 cable (supplied with the CR10KD). No interfacing software is required.

To communicate with any device other than the CR10KD, the CR10 enters its Telecommunications Mode and responds only to valid telecommunications commands. Within the Telecommunications Mode, there are 2 "states": the Telecommunications Command state and the Remote Keyboard state. Communication is established in the Telecommunications command state. One of the commands is to enter the Remote Keyboard state.

The Remote Keyboard state allows the keyboard of the computer/terminal to act like the CR10KD yboard. Various datalogger modes may be entered, including the mode in which programs may be keyed in to the CR10 from the computer/terminal.

Campbell Scientific's PC208 Datalogger Support Software facilitates the use of IBM PC/XT/AT/PS-2's and compatibles for communicating with the CR10. This package contains a program editor (EDLOG), a terminal emulator (TERM), telecommunications (TELCOM), a data reduction program (SPLIT), and programs to retrieve data from both generations of Campbell Scientific's Storage Modules (SMREAD and SMCOM).

To participate in the programming examples (Section OV5) you must communicate with the CR10. Read Section OV3.1 if the CR10KD is being used, Section OV3.2 if the PC208 software is being used, or Section 3.3 and Section 5 if some other computer or terminal is being used.

OV3.1 CR10 KEYBOARD/DISPLAY

The SC12 cable (supplied with the CR10KD) is ed to connect the Keyboard/Display to the 9 pin Serial I/O port on the CR10.

If the Keyboard/Display is connected to the CR10 prior to being powered up, the "HELLO" message is displayed while the CR10 checks memory. The size of the usable system memory is then displayed (96 for 96K bytes of memory). When the CR10KD is plugged in after the CR10 has powered up, the display is meaningless until "*" is pressed to enter a mode.

OV3.2 USING THE PC208 TERMINAL EMULATOR (TERM)

For IBM compatible computers, the PC208 software contains a terminal emulator program called TERM. When using TERM, the baud rate, port, and modem types are specified and stored in a file for future use.

The simplest and most common interface is the SC32A Optically Isolated RS232 Interface. The SC32A converts and optically isolates the voltages passing between the CR10 and the external terminal device.

The SC12 Two Peripheral cable which comes with the SC32A is used to connect the serial I/O port of the CR10 to the 9 pin port of the SC32A labeled "Datalogger". Connect the "Terminal/Printer" port of the SC32A to the serial port of the computer with a straight 25 pin cable or, if the computer has a 9 pin serial port, a standard 9 to 25 pin adaptor cable.

To establish the communication link between the computer and the CR10, the user may either select the T option and send carriage returns as described above or select the "C" option to "Call" the station (see PC208 Operator's Manual). Once the link is active, issue the "7H" command to enter the Remote Keyboard State.

OV3.3 ASCII TERMINAL OR COMPUTER WITH TERMINAL EMULATOR

Devices which can be used to communicate with the CR10 include standard ASCII terminals and computers programmed to function as a terminal emulator.

OV3.3.1 COMPUTER/TERMINAL REQUIREMENTS

The basic requirements are:

1. There must be an asynchronous serial port to transmit and receive characters.
2. Communication protocol must be matched for the two devices.
3. The proper cable/interface must be used between the serial ports.
4. A computer must be programmed to function as a terminal.

While the connection between the computer/terminal and the CR10 may be via modem (phone, RF, or short haul), the most frequently used device for a short connection is the SC32A Optically Isolated RS232 Interface.

Most computer/terminal devices require RS232 input logic levels of -5V for logic low and +5V for logic high. Logic levels from the CR10's serial I/O port are 0V for logic low and +5V for logic high.

The SC32A converts and optically isolates the voltages passing between the CR10 and the external terminal device. The SC32A is configured as Data Communications Equipment (DCE) for direct connection to Data Terminal Equipment (DTE) which includes most computers and terminals.

The SC12 Two Peripheral cable which comes with the SC32A is used to connect the serial I/O port of the CR10 to the 9 pin port of the SC32A labeled "Datalogger". Connect the "Terminal/Printer" port of the SC32A to the serial port of the terminal with a user supplied straight cable with the proper connectors (Campbell Scientific SC25PS or equivalent for a 25 pin serial port configured DTE).

OV3.3.2 ESTABLISHING COMMUNICATION WITH THE CR10

Communication software is available for most computers having a serial port. Campbell Scientific's PC208 Datalogger Support Software is available for IBM PC/XT/AT/PS-2's and compatibles. The software must be capable of the following communication protocol:

1. Configuring an asynchronous serial port for 8 Data Bits, 1 Stop Bit, no Parity, and Full Duplex at baud rates of 300, 1200, or 9600 baud.
2. Transmitting characters typed on the keyboard out through the serial port.
3. Displaying characters/data received through the computer's serial port.

Once the computer is functioning as a terminal, initiate communications by sending the CR10 several carriage returns for the CR10 to match the baud rate and respond with "*". Enter the 7H command to enter the Remote Keyboard State. At this point, the CR10 can be controlled using the Keyboard Commands described in Section OV4. For additional information on communications, see Section 6.7.

OV4. PROGRAMMING THE CR10

A program is created by entering it directly into the datalogger or on a computer using the PC208 Datalogger Support Software program EDLOG. This manual describes direct interaction with the CR10. Work through the direct programming examples in this overview before using EDLOG and you will have the basics of CR10 operation as well as an appreciation for the help provided by the software. Section OV4.5 describes options for loading the program into the CR10.

OV4.1 FUNCTIONAL MODES

CR10/User interaction is broken into different functional MODES (e.g., programming the measurements and output, setting time, manually initiating a block data transfer to Storage Module, etc.). The modes are referred to as Star (*) Modes since they are accessed by first keying *, then the mode number or letter. Table OV4-1 lists the CR10 Modes.

TABLE OV4.1-1. * Mode Summary

Key	Mode
*0	LOG data and indicate active Tables
*1	Program Table 1
*2	Program Table 2
*3	Program Table 3, subroutines only
*4	Enable/disable tape and/or printer output
*5	Display/set real time clock
*6	Display/alter Input Storage data, toggle flags
*7	Display Final Storage data
*8	Final Storage data transfer to cassette tape
*9	Final Storage data transfer to printer
*A	Memory allocation/reset
*B	Signature/status
*C	Security
*D	Save/load Program

OV4.2 KEY DEFINITION

Keys and key sequences have specific functions when using the CR10KD keyboard or a computer/terminal in the remote keyboard state (Section 5). Table OV4-2 lists these functions. In some cases, the exact action of a key depends on the mode the CR10 is in and is described with the mode in the manual.

TABLE OV4.2-1. Key Description/Editing Functions

Key	Action
0-9	Key numeric entries into display
*	Enter Mode (followed by Mode Number)
A	Enter/Advance
B	Back up
C	Change the sign of a number or index an input location to loop counter
D	Enter the decimal point

#	Clear the rightmost digit keyed into the display
#A	Advance to next instruction in program table (*1, *2, *3) or to next Output Array in Final Storage (*7)
#B	Back up to previous instruction in program table or to previous Output Array in Final Storage
#D	Delete entire instruction
#0	(then A or CR) Back up to the start of the current array.

When using a computer/terminal to communicate with the CR10 (Telecommunications) there are some keys available in addition to those found on the CR10KD. Table OV4.2-2 lists these keys.

TABLE OV4.2-2. Additional Keys Allowed in Telecommunications

Key	Action
-	Change Sign, Index (same as C)
CR	Enter/advance (same as A)
:	Colon (used in setting time)
S or ^S	Stops transmission of data (10 second time-out; any character restarts)
C or ^C	Aborts transmission of Data

OV4.3 PROGRAMMING SEQUENCE

In routine applications, the CR10 measures sensor output signals, processes the measurements over some time interval and stores the processed results. A generalized programming sequence is:

1. Enter the execution interval. In most cases, the execution interval is determined by the desired sensor scan rate.

2. Enter the Input/Output instructions required to measure the sensors.

3. If processing in addition to that provided by the Output Processing Instructions (step 5) is required, enter the appropriate Processing Instructions.

4. Enter the Program Control Instruction to test the output condition and set the Output Flag when the condition is met. For example, use

   Instruction 92 to output based on time.

   Instruction 86 to output every execution interval.

   Instruction 88 or 89 to output based on a comparison of values in input locations.

   This instruction must precede the Output Processing Instructions which store data in Final Storage. Instructions are described in Sections 9 through 12.

5. Enter the Output Processing Instructions to store processed data in Final Storage. The order in which data are stored is determined by the order of the Output Processing Instructions in the table.

6. Repeat steps 4 through 6 for additional outputs on different intervals or conditions.

> NOTE: The program must be executed for output to occur. Therefore, the interval at which the Output Flag is set must be evenly divisible by the execution interval. For example, with a 2 minute execution interval and a 5 minute output interval, the program will only be executed on the even multiples of the 5 minute intervals, not on the odd. Data will be output every 10 minutes instead of every 5 minutes.

Execution intervals and output intervals set with Instruction 92 are synchronized with real time starting at midnight.

OV4.4 INSTRUCTION FORMAT

Instructions are identified by an instruction number. Each instruction has a number of parameters that give the CR10 the information it needs to execute the instruction.

The CR10 Prompt Sheet has the instruction numbers in red, with the parameters briefly listed in columns following the description. Some parameters are footnoted with further description under the "Instruction Option Codes" heading.

For example, Instruction 73 stores the maximum value that occurred in an Input Storage location over the output interval. The instruction has three parameters (1) REPetitionS, the number of sequential Input Storage locations on which to find maxima, (2) TIME, an option of storing the time of occurrence with the maximum value, and (3) LOC the first Input Storage location operated on by the Maximum Instruction. The codes for the TIME parameter are listed in the "Instruction Option Codes".

The repetitions parameter specifies how many times an instruction's function is to be repeated. For example, four 107 thermistor probes may be measured with a single Instruction 11, Temp-107, with four repetitions. Parameter 2 specifies the input channel of the first thermistor (the probes must be connected to sequential channels). Parameter 4 specifies the Input Storage location in which to store measurements from the first thermistor. If location 5 were used and the first probe was on channel 1, the temperature of the thermistor on channel 1 would be stored in input location 5, the temperature from channel 2 in input location 6, etc.

Detailed descriptions of the instructions are given in Sections 9-12. Entering an instruction into a program table is described in OV5.

OV4.5 ENTERING A PROGRAM

Programs are entered into the CR10 in one of three ways:

1. Keyed in using the CR10 keyboard.
2. Loaded from a pre-recorded listing using the *D Mode. There are 3 types of storage/input:
   a. Stored on disk/sent from computer (PC208 software TERM and EDLOG).
   b. Stored/loaded from SM192/716 Storage Module.
   c. Stored/loaded from tape using SC93A Interface. (Special software only, see Appendix B.)
3. Loaded from internal PROM (special software) or Storage Module upon power-up.

A program is created by keying it directly into the datalogger as described in Section OV5, or on a PC using the PC208 Datalogger Support Software.

EDLOG and TERM are PC208 Software programs used to develop and send programs to Campbell Scientific dataloggers. EDLOG is a prompting editor for writing and documenting programs for Campbell Scientific dataloggers. Program files developed with EDLOG can be downloaded directly to the CR10 using TERM. TERM supports communication via direct wire, telephone, or Radio Frequency (RF).

Programs on disk can be copied to a Storage Module with SMCOM. Using the *D Mode to save or load a program from a Storage Module is described in Section 1.8.

It is possible (with special software) to create a PROM (Programmable Read Only Memory) that contains a datalogger program. With this PROM installed in the datalogger, the program will automatically be loaded and run when the datalogger is powered-up, requiring only that the clock be set.

The program on power up function can be achieved by using a SM192/716 Storage Module. Up to 8 programs can be stored in the Storage Module, the programs may be assigned any of the numbers 1-8. If the Storage Module is connected when the CR10 is powered-up the CR10 will automatically load program number 8, provided that a program 8 is loaded in the Storage Module (Section 1.8).

OV5. PROGRAMMING EXAMPLES

We will start with a simple programming example. There is a brief explanation of each step to help you follow the logic. When the example uses an instruction, find it on the Prompt Sheet and follow through the description of the parameters. Using the Prompt Sheet while going through these examples will help you become familiar with its format. Sections 9-12 have more detailed descriptions of the instructions.

With the Wiring Panel connected to the CR10, hook up the power leads as described in Section OV1.2. Next, connect the CR10 to either a CR10KD Keyboard/Display or a terminal (Section OV2). If using a terminal, use the 7H command to get into the Remote Keyboard State (Sections 5.2). The programming steps in the following examples use the keystrokes possible on the keyboard/display. With a terminal, some responses will be slightly different.

If the CR10KD is connected to the CR10 when it is powered up, the display will show:

Display	Explanation
HELLO	On power-up, the CR10 displays "HELLO" while it checks the memory (this display occurs only with the CR10KD).

after a few seconds delay

:96	The size of the machine's total memory (RAM plus 32 K of ROM), in this case 96K

OV5.1 SAMPLE PROGRAM 1

In this example the CR10 is programmed to read its own internal temperature (using a built in thermistor) every 5 seconds and to send the results to Final Storage.

Key	Display Will Show: (ID:Data)	Explanation
*	00:00	Enter mode.
1	01:00	Enter Program Table 1.
A	01:0.0000	Advance to execution interval (in seconds)
5	01:5	Key in an execution interval of 5 seconds.
A	01:P00	Enter the 5 second execution interval and advance to the first program instruction location.
17	01:P17	Key in Instruction 17 which directs the CR10 to measure the internal temperature in degrees C. This is an Input/Output Instruction.
A	01:0000	Enter Instruction 17 and advance to the first parameter.
1	01:1	The input location to store the measurement, location 1.
A	02:P00	Enter the location # and advance to the second program instruction.

The CR10 is now programmed to read the internal temperature every 5 seconds and place the reading in Input Storage Location 1. The program can be compiled and the temperature displayed.

Key	Display Will Show: (ID:Data)	Explanation
*0	LOG 1	Exit Table 1, enter *0 Mode, compile table and begin logging.
*6	06:0000	Enter *6 Mode (to view Input Storage).
A	01:21.234	Advance to first storage location. Panel temperature is 21.234 °C (the display will show the actual temperature).

Key	Display Will Show: (ID:Data)	Explanation
	Wait a few seconds:	
	01:21.423	The CR10 has read the sensor and stored the result again. The internal temp is now 21.423 °C. The value is updated every 5 seconds when the table is executed. At this point the CR10 is measuring the temperature every 5 seconds and sending the value to Input Storage. No data are being saved. The next step is to have the CR10 send each reading to Final Storage. (Remember, the Output Flag must be set first.)
*1	01:00	Exit *6 Mode. Enter program table 1.
2A	02:P00	Advance to 2nd instruction location (this is where we left off).
86	02:P86	This is the DO instruction (a Program Control Instruction).
A	01:00	Enter 86 and advance to the first parameter (which will specify the command to execute).
10	01:10	This command sets the Output Flag. (Flag 0)
A	03:P00	Enter 10 and advance to third program instruction.
70	03:P70	The SAMPLE instruction. It directs the CR10 to take a reading from an Input Storage location and send it to Final Storage (an Output Processing Instruction).
A	01:0000	Enter 70 and advance to the first parameter (repetitions).
1	01:1	There is only one input location to sample; repetitions = 1.
A	02:0000	Enter 1 and advance to second parameter (Input Storage location to sample).
1	02:1	Input Storage Location 1, where the temperature is stored.
A	04:P00	Enter 1 and advance to fourth program instruction.
*	00:00	Exit Table 1.
0	LOG 1	Enter *0 Mode, compile program, log data.

*The CR10 is now programmed to measure the internal temperature every 5 seconds and send each reading to Final Storage. Values in Final Storage can be viewed using the *7 Mode.*

Key	Display Will Show: (ID:Data)	Explanation
*7	07: 13.000	Enter *7 Mode. The DSP is at Location 13 (in this example).
A	01: 0102	Advance to the first value, the Output Array ID. 102 indicates the Output Flag was set by the second instruction in Program Table 1.
A	02: 21.23	Advance to the first stored temperature.
A	01: 0102	Advance to the next output array. Same Output Array ID.
A	02: 21.42	Advance to 2nd stored temp, 21.42 deg. C.

There are no date and time tags on the data. They must be put there with Output Instruction 77. Instruction 77 is used in the next example.

If a terminal is used to communicate with the CR10, Telecommunications Commands (Section 5) can be used to view entire Output Arrays (in this case the ID and temperature) at the same ie.

OV5.2 SAMPLE PROGRAM 2

This second example is more representative of a real-life data collection situation. Once again the internal temperature is measured, but it is used as a reference temperature for the differential voltage measurement of a type T (copper-constantan) thermocouple; the CR10 should have arrived with a short type T thermocouple connected to differential channel 5.

When using a type T thermocouple, the copper lead (blue) is connected to the high input of the differential channel, and the constantan lead (red) is connected to the low input.

A thermocouple produces a voltage that is proportional to the difference in temperature between the measurement and the reference junctions.

To make a thermocouple (TC) temperature measurement, the temperature of the reference junction (in this example, the approximate panel perature) must be measured. The CR10 es the reference temperature, converts it to the equivalent TC voltage relative to 0°C, adds the measured TC voltage, and converts the sum to temperature through a polynomial fit to the TC output curve (Section 13.4).

The internal temperature of the CR10 is not a suitable reference temperature for precision thermocouple measurements. It is used here for the purpose of training only. To make thermocouple measurements with the CR10, purchase the Campbell Scientific Thermocouple Reference, Model 10TCRT (Section 13.4) and make the reference temperature measurement with Instruction 11.

Instruction 14 directs the CR10 to make a differential TC temperature measurement. The first parameter in Instruction 14 is the number of times to repeat the measurement. Enter 1, because in this example there is only one thermocouple. If there were more than 1 TC, they could be wired to sequential channels, and the number of thermocouples entered for repetitions. The CR10 would automatically advance through the channels sequentially and measure all of the thermocouples.

Parameter 2 is the voltage range to use when making the measurement. The output of a type T thermocouple is approximately 40 microvolts per degree C difference in temperature between the two junctions. The ±2.5 mV scale will provide a range of +2500/40 = +62.5 °C (i.e., this scale will not overrange as long as the measuring junction is within 62.5 °C of the panel temperature). The resolution of the ±2.5 mV range is 0.33 μV or 0.008 °C.

Parameter 3 is the analog input channel on which to make the first, and in this case only, measurement.

Parameter 4 is the code for the type of thermocouple used. This information is located on the Prompt Sheet or in the description of Instruction 14 in Section 9. The code for a type T (copper-constantan) thermocouple is 1.

Parameter 5 is the Input Storage location in which the reference temperature is stored. Parameter 6 is the Input Storage location in which to store the measurement (or the first measurement; e.g., if there are 5 repetitions and the first measurement is stored in location 3, the final measurement will be stored in location 7). Parameters 7 and 8 are the multiplier and offset. A multiplier of 1 and an offset of 0 outputs the reading in degrees C. A multiplier of 1.8 and an offset of 32 converts the reading to degrees F.

In this example, the sensor is measured once a minute, and the day, time, and average temperature are output every hour. Once a day the day, time, maximum and minimum temperatures and the times they occur will be output.

Final Storage data will be sent to Storage Module. Remember, all on-line data output to a peripheral device is accomplished with Instruction 96 (Sections 4.1 and 12).

The first example described program entry one keystroke at a time. This example does not show the "A" key. Remember, "A" is used to enter and/or advance (i.e., between each line in the example below). This format is similar to the format used in EDLOG.

It's a good idea to have both the manual and the Prompt Sheet handy when going through this example. You can find the program instructions and parameters on the Prompt Sheet and can read their complete definitions in the manual.

SAMPLE PROGRAM 2

Instruction # (Loc:Entry)	Parameter (Par#:Entry)	Description
*1		Enter Program Table 1
01:60		60 second (1 minute) execution interval
Key "#D" until is displayed	01:P00	Erase previous Program before continuing.
01:P17		Measure Internal temperature
	01:1	Store temp in Location 1
02:P14		Measure thermocouple temperature (differential)
	01:1	1 repetition
	02:1	Range code (2.5 mV, slow)
	03:5	Input channel of TC
	04:1	TC type: copper-constantan
	05:1	Reference temp is stored in Location 1
	06:2	Store TC temp in Location 2
	07:1	Multiplier of 1
	08:0	No offset

Instruction # (Loc.:Entry)	Parameter Par.#:Entry)	Description
03:P92		If Time instruction
	01:0	0 minutes into the interval
	02:60	60 minute interval
	03:10	Set Output Flag 0

The CR10 is programmed to measure the thermocouple temperature every sixty seconds. The If Time instruction sets the Output Flag at the beginning of every hour. Next, the Output Instructions for time and average are added.

04:P77		Output Time instruction
	01:110	Store Julian day, hour, and minute
05:P71		Average Instruction
	01:1	one repetition
	02:2	Location 2 - source of TC temps. to be averaged

To obtain daily output, the If Time instruction is again used to set the Output Flag and is followed by the Output Instructions to store time and the daily maximum and minimum temperatures and the time each occurs.

Any Program Control Instruction which is used to set the Output Flag high will set it low if the conditions are not met for setting it high. Instruction 92 above sets the Output Flag high every hour. The Output Instructions which follow do not output every hour because they are preceded by another Instruction 92 which sets the Output Flag high at midnight (and sets it low at any other time). This is a unique feature of Flag 0. The Output Flag is set low at the start of each table (Section 3.7).

Instruction # (Loc.:Entry)	Parameter (Par.#:Entry)	Description
06:P92		If Time instruction
	01:0	0 minutes into the interval
	02:1440	1440 minute interval (24 hrs.)
	03:10	Set Output Flag 0
07: P77		Output Time instruction
	01:100	Store Julian day
08: P73		Maximize instruction
	01:1	One repetition
	02:10	Output the time of the daily maximum in hours and minutes
	03:2	Data source is Input Storage Location 2.

Instruction # (Loc.:Entry)	Parameter (Par.#:Entry)	Description
09: P74		Minimize instruction
	01:1	One repetition
	02:10	Output the time of the daily minimum in hours and minutes
	03:2	Data source is Input Storage Location 2.

The program to make the measurements and to send the desired data to Final Storage has been entered. At this point, Instruction 96 is entered to enable data transfer from Final Storage to Storage Module.

10:P96		Activate Serial Data Output.
	1:71	Output Final Storage data to Storage Module.

The program is complete. The clock must now be set so that the date and time tags are correct. (Here the example reverts back to the key by key format.)

Key	Display	Explanation
*5	00:21:32	Enter *5 Mode. Clock running but not set correctly.
A	05:00	Advance to location for year.
86	05:86	Key in year (1986).
A	05:0000	Enter and advance to location for Julian day.
197	05:197	Key in Julian day.
A	05:0021	Enter and advance to location for hours and minutes (24 hr. time).
1324	05:1324	Key in hrs.:min. (1:24 PM in this example).
A	:13:24:01	Clock set and running.
*0	LOG 1	Exit *5, compile Table 1, commence logging data.

OV5.3 EDITING AN EXISTING PROGRAM

When editing an existing program in the CR10, entering a new instruction inserts the instruction; entering a new parameter replaces the previous value.

To insert an instruction, enter the program table and advance to the position where the instruction is to be inserted (i.e., P in the data portion of the display) key in the instruction number, and then key A. The new instruction will be inserted at that point in the table, advance through and enter the parameters. The instruction that was at that point and all instructions following it will be pushed down to follow the inserted instruction.

An instruction is deleted by advancing to the instruction number (P in display) and keying #D (Table 4.2-1).

To change the value entered for a parameter, advance to the parameter and key in the correct value then press A. Note that the new value is not entered until A is keyed.

OV6. DATA RETRIEVAL OPTIONS

There are several options for data storage and retrieval. These options are covered in detail in Sections 2, 4, and 5. Figure OV6.1-1 summarizes the various possible methods.

Regardless of the method used, there are three general approaches to retrieving data from a datalogger.

1) On-line output of Final Storage data to a peripheral storage device. On a regular schedule, that storage device is either "milked" of its data or is brought back to the office/lab where the data is transferred to the computer. In the latter case, a "fresh" storage device is usually left in the field when the full one is taken so that data collection can continue uninterrupted.
2) Bring a storage device to the datalogger and milk all the data that has accumulated in Final Storage since the last visit.
3) Retrieve the data over some form of telecommunications link, whether it be RF, telephone, short haul modem, or satellite. This can be performed under program control or by regularly scheduled polling of the dataloggers. Campbell Scientific's TELCOM program automates this process for IBM PC/XT/AT/PS-2's and compatibles.

Regardless of which method is used, the retrieval of data from the datalogger does NOT erase those data from Final Storage. The data remain in the ring memory until:

- they are written over by new data (Section 2.1)
- memory is reallocated (Section 1.5)
- the power to the datalogger is turned off.

Table OV6.1-1 lists the instructions used with the various methods of data retrieval.

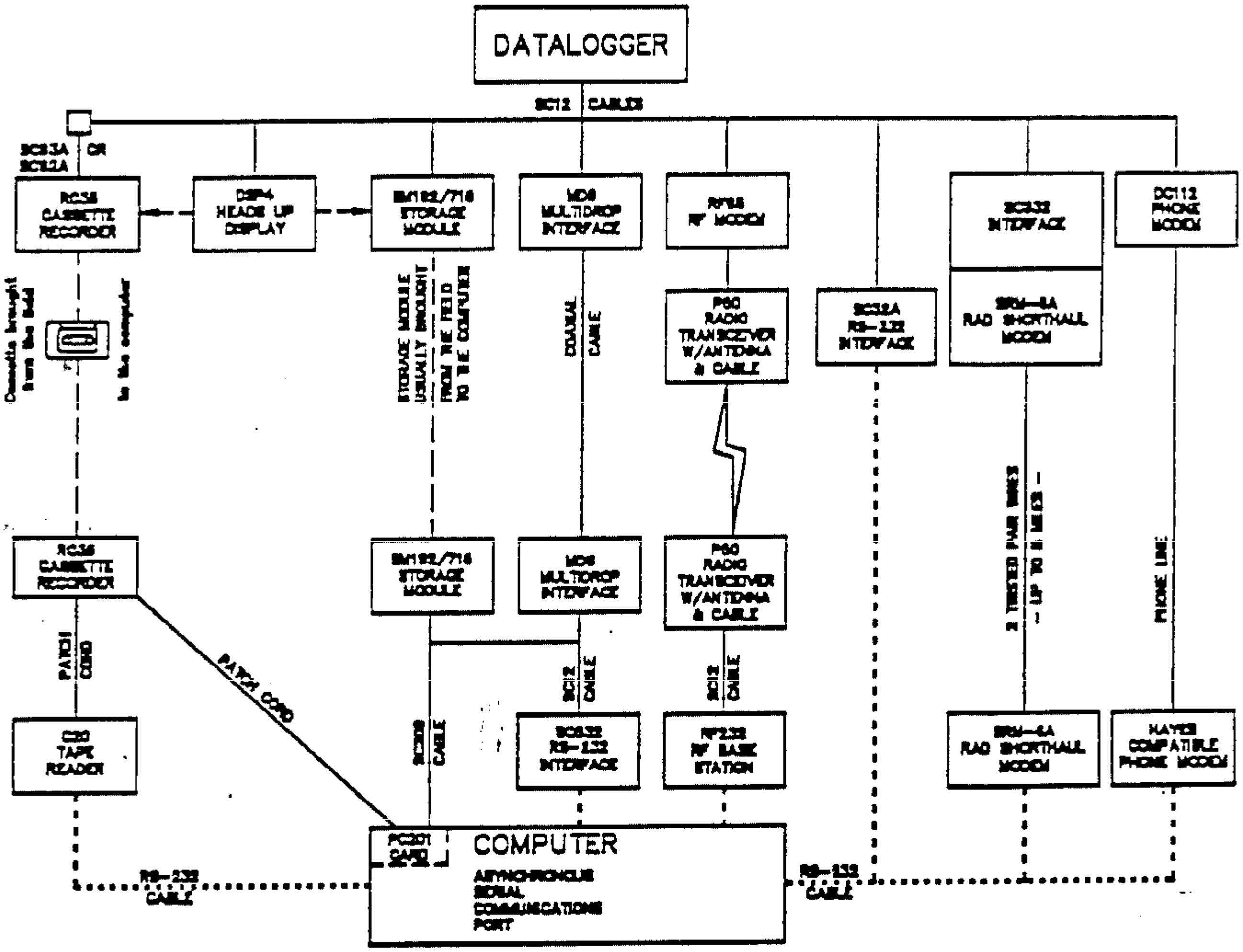
TABLE OV6.1-1. Data Retrieval Methods and Related Instructions

Cassette Tape	Storage Module	Printer, other Serial Device	Telecommunications (RF, Phone, Short Haul, SC32A)
Inst. 96	Inst. 96, *8	Inst. 96, *8	Inst. 97
*8	*9	Inst. 98,	(Telecommunications Commands)

TABLE OV6.1-2. Data Retrieval Sections in Manual

Instruction or Mode	Section in Manual
96	4.1, 12
Instr. 97	12
*8	4.2
*9	4.5
Telecommunications	5

DATA RETRIEVAL



NOTES:

1. ADDITIONAL METHODS OF DATA RETRIEVAL ARE:
   A. SATELLITE TRANSMISSION
   B. DIRECT DUMP TO PRINTER

2. THE DSP4 HEADS UP DISPLAY ALLOWS THE USER TO VIEW DATA IN INPUT STORAGE. ALSO BUFFERS FINAL STORAGE DATA AND WRITES IT TO CASSETTE TAPE, PRINTER OR STORAGE MODULE.

3. ALL CAMPBELL SCIENTIFIC RS-232 INTERFACES HAVE A FEMALE 25 PIN RS-232 CONNECTOR.

FIGURE OV6.1-1. Data Retrieval Hardware Options

OV7. SPECIFICATIONS

The following electrical specifications are valid for an ambient temperature range of -25° to +50°C unless otherwise specifie

ANALOG INPUTS

NUMBER OF CHANNELS: 6 differential or up to 12 single-ended. Each differential channel can be configured as two single-ended channels.

CHANNEL EXPANSION: The Model AM416 Relay Multiplexer allows an additional 64 single-ended channels to multiplex into four CR10 single-ended channels. Up to three AM416's can be connected to one CR10.

ACCURACY OF VOLTAGE MEASUREMENTS AND ANALOG OUTPUT VOLTAGES:
0.2% of FSR, 0.1% of FSR (0 to 40°C)

RANGE AND RESOLUTION: Ranges are software selectable for any channel. Resolution for a single-ended measurement is twice the value shown.

Full Scale Range	**Resolution**
± 2500 millivolts	333 microvolts
± 250 millivolts	33.3 microvolts
± 25 millivolts	3.33 microvolts
± 7.5 millivolts	1.00 microvolts
± 2.5 millivolts	0.33 microvolts

INPUT SAMPLE RATES: The fast A/D conversion uses a 0.25 ms signal integration time and the slow conversion uses a 2.72 ms signal integration. Two integrations, separated in time by 1/2 of an AC line cycle, are used with the 60 Hz or 50 Hz noise rejection option. Differential measurements include a second sampling with reversed input polarity to reduce thermal offset and common mode errors. Input sample rates are the time required to measure and convert the result to engineering units.

Fast single-ended voltage:	2.6 ms
Fast differential voltage:	4.2 ms
Slow single-ended voltage:	5.1 ms
Slow differential voltage:	9.2 ms
Differential with 60 Hz rejection:	25.9 ms
Fast differential thermocouple:	8.6 ms

INPUT NOISE VOLTAGE:

Fast differential	— 0.82 microvolts RMS
Slow differential	— 0.25 microvolts RMS
Differential with 60 Hz rejection	— 0.18 microvolts RMS

COMMON MODE RANGE: ± 2.5 volts.

DC COMMON MODE REJECTION: > 140 dB.

NORMAL MODE REJECTION: 70 dB
(60 Hz with slow differential measurement).

INPUT CURRENT: 3 nanoamps maximum.

INPUT RESISTANCE: 200 gigohms.

EXCITATION OUTPUTS

DESCRIPTION: The CR10 has 3 switched excitations, active only during measurement, with only one output active at any time. The off state is high impedance.

RANGE: ± 2.5 volts.

RESOLUTION: 0.67 millivolts.

ACCURACY: Same as voltage input.

OUTPUT CURRENT: 20 mA @ ± 2.5 V; 35 mA @ ± 2.0 V; 50 mA @ ± 1.5 V.

FREQUENCY SWEEP FUNCTION: A swept frequency, square wave output between 0 and 2.5 volts is provided for vibrating wire transducers. Timing and frequency range are specified by the instruction.

RESISTANCE AND CONDUCTIVITY MEASUREMENTS

ACCURACY: 0.015% of full scale bridge output, limited by the matching bridge resistors. The excitation voltage should be programmed so the bridge output matches the full scale input voltage range.

MEASUREMENT TYPES: 6-wire and 4-wire full bridge, 4-wire, 3-wire, and 2-wire half bridge. Bridge measurements are ratiometric and dual polarity to eliminate thermal emf's. AC resistance measurements use a dual polarity 0.75 ms excitation pulse for ionic depolarization, with the signal integration occurring over the last 0.25 ms.

PERIOD AVERAGING MEASUREMENTS

DEFINITION: The time period for a specified number of cycles of an input frequency is measured, then divided by the number of cycles to obtain the average period of a single cycle.

INPUTS: Any single-ended analog channel; signal dividing or AC coupling is normally required.

INPUT FREQUENCY RANGE:

Range Code	**Peak to Peak Volts Required @ Max. Freq.***	**Maximum Frequency**
1	2 mV	8 kHz
2	3 mV	20 kHz
3	12 mV	50 kHz
4	2000 mV	200 kHz

*AC voltage; must be centered around CR10 ground

REFERENCE ACCURACY: ± 40 ppm.

RESOLUTION: ± 100 nanoseconds divided by the number of cycles measured. Resolution is reduced by signal noise and for signals with a slow transition through the zero voltage threshold.

TIME REQUIRED FOR MEASUREMENT: Signal period times the number of cycles measured plus 1.5 cycles.

PULSE COUNTERS

NUMBER OF PULSE COUNTER CHANNELS: 2 eight bit or 1 sixteen bit; software selectable.

MAXIMUM COUNT RATE: 2000 Hz, eight bit counter; 250 kHz, sixteen bit counter. Pulse counter channels are scanned at 8 Hz.

MODES: Switch closure, high frequency pulse, and low level AC.

SWITCH CLOSURE MODE
Minimum Switch Closed Time: 5 milliseconds.
Minimum Switch Open Time: 6 milliseconds.
Maximum Bounce Time: 1 millisecond open without being counted.

HIGH FREQUENCY PULSE MODE
Minimum Pulse Width: 0.002 milliseconds.
Maximum Input Frequency: 250 kHz.
Voltage Thresholds: Count upon transition from below 1.5 V to above 3.5 V.
Maximum Input Voltage: ± 20 V.

LOW LEVEL AC MODE
(Typical of magnetic pulse flow transducers or other low voltage, sine wave outputs).
Minimum AC Input Voltage: 6 mV RMS.
Input Hysteresis: 11 mV.
Maximum AC Input Voltage: 20 V RMS.

Frequency Range:

AC Input (RMS)	**Range**
20 mV	1 Hz to 1
50 mV	0.5 Hz to 4
150 mV to 20 V	0.3 Hz to 1

(Consult factory if higher frequencies are

DIGITAL I/O PORTS

8 ports, software selectable as binary inputs or co outputs.

OUTPUT VOLTAGES (no load): high 5.0 V ± low < 0.1 V.

OUTPUT RESISTANCE: 500 Ω.

INPUT STATE: high 3.0 V to 5.5 V, low -0.5 V to

INPUT RESISTANCE: 100 kΩ.

SDI-12 INTERFACE STANDARD

This communication protocol, developed for m cessor-based hydrologic and environmental s available as a software option in the CR10.

SENSOR CONNECTIONS: Digital I/O Port #8 (f asynchronous communication), 12V powe a ground. Up to ten SDI-12 sensors can be connected to a CR10.

TRANSIENT PROTECTION

All input and output connections to the CR10 modu are protected using RC filters or transzorbs conne to a heavy copper bar between the circuit card a case. The CR10WP Wiring Panel includes ac spark gap and transzorb protection.

CPU AND INTERFACE

PROCESSOR: Hitachi 6303.

MEMORY: 32K ROM, 64K RAM.

DISPLAY: 8 digit LCD (0.5" digits).

PERIPHERAL INTERFACE: 9 pin D-type connec keyboard display, storage module, modem, cassette, and RS-232 adapter. Baud rates se able at 300, 1200, 9600 and 76,800. ASCII co munication protocol is one start bit, one stop b eight data bits (no parity).

CLOCK ACCURACY: ± 1 minute per month.

MAXIMUM PROGRAM EXECUTION RATE: Syste tasks initiated in sync with real-time up to 64 One measurement with data transfer is poss this rate without interruption.

SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 16 volts.

TYPICAL CURRENT DRAIN: 0.5 mA quiescen 13 mA during processing, and 35 mA during analog measurement.

BATTERIES: Any 12 volt battery can be connecte a primary power source. Enclosures with po supply options are available.

PHYSICAL SPECIFICATIONS

SIZE: 7.8" x 3.5" x 1.5" - Measurement & Contro Module; 9" x 3.5" x 2.9" - with CR10WP W Panel. Additional room required for connectors

WEIGHT: 2 lbs.

WARRANTY

Three years against defects in materials and work ship.

APPENDIX L

Documentation

APPENDIX L

Contents

EG&G Idaho, Inc. **PROGRAM DIRECTIVE** ENVIRONMENTAL RESTORATION PROGRAM	Title: DOCUMENT CONTROL	No.: PD 4.1 Page: 1 of 23 Date: 11/01/91
	Approved: Susan A Stiger Manager, ERP	Legend | = Change

Reviewed by:
Original signatures appear on DRR# ERP-381, release date 10/31/91.

1. PURPOSE AND SCOPE

This program directive (PD) establishes a document control process for issuing, distributing, controlling, and revising Environmental Restoration Program (ERP) assigned documentation.

2. ACRONYMS/DEFINITIONS

ARDC	--	Administrative Record and Document Control
CM	--	Construction Management
CMP	--	Configuration Management Plan
DCN	--	Document Change Notice
DOE	--	Department of Energy
DRR	--	Document Revision Request
ECM	--	Engineering Configuration Management
EDC	--	Engineering Document Control
EDF	--	Engineering Design File
EIRC	--	ERP Independent Review Committee
ERP	--	Environmental Restoration Program
ES	--	Engineering Specification
ESP	--	Engineering Standard Practice
INEL	--	Idaho National Engineering Laboratory
OP	--	Operating Procedure
PD	--	Program Directive
PM	--	Project Manager
SPM	--	Specification Preparation Manual
TBA	--	Task Baseline Agreement

Approval: Formal authoritative permission to issue a document.

Camera-ready: A complete, reviewed, approved, and tech-edited document ready for printing.

Construction Manager: The prime Department of Energy (DOE) contractor responsible for construction activities at the INEL.

Control Process: Compliance process established to control documents (see Section 5.1 of this PD).

Controlled Documents: Numbered documents released or issued through a system that imposes appropriate controls on the origin, change, distribution, receipt, maintenance, return, and recall of the documents. (Reference 1) (Appendix A)

2. ACRONYMS/DEFINITIONS (continued)

Copyholder: Recipient of controlled documents.

Document Control Coordinator: Individual within Administrative Record and Document Control (ARDC) who controls and distributes copies of documents.

Document Control Number: Unique number assigned to each controlled document by ARDC.

Document Number: An EG&G Idaho, Inc., report number (i.e., EGG-WM-XXXX).

Document Revision Request (DRR): Form EG&G-1844 (Appendix B) used to authorize documents and control changes to several types of documents, unless another specific form is required.

Field Change: A change originating at the task site to an approved controlled document when (a) specified task cannot be performed as written, (b) work directions are unsafe as written, or (c) significant productivity savings can be realized without adverse effects.

Information-Only Copy: A copy of a controlled document that is not maintained current and therefore may not contain up-to-date or approved information. Information-Only copies are labeled as such and not assigned control numbers.

Issue Sheet: Transmittal page attached to controlled document package requiring copyholder's signature, date, and return to ARDC.

Minor Change: Changes to documents, such as spelling, grammar, punctuation, and other inconsequential editorial corrections that do not change meaning. (Reference 1)

Operations Number: An alternate DRR number (e.g., MHR-01) when a DRR number cannot be obtained due to off-shift field work or remote location.

Proprietary Information: Information that a company considers relevant to its status or operations and does not want to disclose or cannot disclose to the public without proper authorization.

Requester: Individual desiring a change in an existing document or one who initiates a new document.

3. POLICY

All ERP-controlled documents requiring issue or update will be processed through ARDC.

3. POLICY (continued)

3.1 ERP Unit Managers shall approve a distribution list for all controlled documents generated by the respective unit.

3.2 Copyholders of controlled documents that are out of compliance with the control process will be removed from the documents' controlled distribution list.

3.3 Copyholders of controlled documents shall immediately notify ARDC when ownership of the document is transferred.

3.4 Copyholders of controlled documents are responsible for performing the actions as instructed on the controlled document issue sheets, including reading, filing updates, signing, dating, and returning to ARDC.

3.5 Copyholders of controlled documents are responsible for the return of controlled documents to ARDC when no longer needed and upon termination of employment.

3.6 ARDC shall conduct quarterly surveillance of maintenance by copyholder of controlled document and review of Appendix A.

3.7 Minor changes (as defined in Section 2) do not require that the revised document receive the same review and approval as the original document (Reference 1).

4. PROCEDURES

Any person performing work for ERP may initiate issuance of documentation or suggest changes. The person submitting a new document or changing an existing document will submit the request on DRR Form EG&G-1844 with approval by appropriate ERP Unit Manager.

5. REQUIREMENTS

5.1 <u>New Controlled Document</u>

Requester	.1	Prepares draft of new document per ERP PD 4.4 (Reference 2).
	.2	Requests document number from ARDC.
ARDC Document Control Coordinator	.3	Assigns document number.
Requester	.4	Obtains review/approval signatures per PD 2.2 (Reference 3).

5.1 New Controlled Document (continued)

Requester (continued)	.5	Completes DRR blocks 2, 3, 5, 6, 8, and 10.
	.6	Attaches approved document to DRR.
	.7	Forwards DRR and attachments to requester's manager for initialing in block 2 of DRR. Submits DRR and attachments to Unit Manager, requesting distribution list for controlled document.
Unit Manager	.8	Initials block 2 of DRR and returns to requester. Provides requester with distribution list for controlled document.
Requester	.9	Submits to ARDC: • DRR plus any attachments • Camera-ready approved document • Other information required by PD 4.4 • Unit Manager distribution list.
ARDC Document Control Coordinator	.10	Assigns DRR number per DRR log and places on DRR in block 4.
	.11	Verifies package is complete per ERP PD 4.4.
	.12	Prepares printing request (Form EG&G-95) (Appendix B).
	.13	Initiates control process (see Section 5.4 of this PD).

5.2 Revision to Controlled Document

Requester	.1	Prepares draft of revised document using copy of original disk from ARDC.
	.2	Obtains technical editing and appropriate review (see ERP PDs 2.2 and 4.4).
	.3	Completes DRR blocks 2, 3, 5, 6, 8, and 10.

5.2 Revision to Controlled Document (continued)

Requester (continued)	.4	Obtains review/approval signatures per ERP PD 2.2.
	.5	Attaches approved revised document to DRR.
	.6	Forwards DRR and revised document to requester's manager for initialing in block 2 of DRR. Submits DRR and attachments to appropriate Unit Manager for update to distribution list for a controlled document.
Unit Manager	.7	Initials block 2 of DRR. Provides updates to distribution list for controlled document to requester.
Requester	.8	Submits to ARDC: • DRR plus any attachments • Camera-ready, approved, revised document • Other information required by PD 4.4 • Unit Manager updates to distribution list.
ARDC Document Control Coordinator	.9	Assigns DRR number per DRR log and places on DRR in block 4.
	.10	Updates distribution list for controlled document per Unit Manager revised distribution list.
	.11	Issues document or revisions per distribution list.
	.12	Initiates Control Process (see Section 5.4 of this PD).
Copyholder	.13	Updates controlled document in accordance with provided issue sheet instructions.

5.3 Field Change Process

Requester	.1	Obtains necessary review/approval signatures (minimum: Quality, Safety, and Project Manager signature) (telecon when necessary). Assigns an operations number when a DRR number cannot be obtained because of off-shift or remote location.
	.2	Marks the appropriate places or steps in the controlled field copy document with "see DRR or operations number." All changes will be listed on the DRR and not transcribed into the document. Attaches copy of DRR to controlled field copy document.
	.3	Requests DRR number from ARDC as soon as possible and provides copy of original DRR to ARDC.
ARDC Document Control Coordinator	.4	Assigns DRR number per DRR log and sends copy of DRR with issue sheet to controlled copy holders.
Requester	.5	Upon completion of the field work, implements Section 5.2 of this PD for permanent changes.

5.4 Control Process

ARDC Document Control Coordinator	.1	Attaches issue sheet to document to be controlled.
	.2	Issues document per Unit Manager supplied distribution list.
Copyholder	.3	Completes and returns issue sheet to ARDC upon receipt of document.
ARDC Document Control Coordinator	.4	Within 15 working days of distribution verifies that issue sheet for each controlled document is returned.
Either	.5a	Files issue sheets.
or	.5b	After 15 working days initiates inquiry with copyholder regarding return of issue sheet.

5.4 <u>Control Process</u> (continued)

Copyholder	.6	If inquiry is made by ARDC, provides ARDC with issue sheet.
ARDC Document Control Coordinator	.7	If issue sheet still is not returned to ARDC within 15 working days of inquiry, notifies copyholder's Unit Manager and repeats steps 5.4.4 through 5.4.5a.
Unit Manager	.8	If notification is made by ARDC, advises copyholder of need to return issue sheet to ARDC.
ARDC Document Control Coordinator	.9	If issue sheet is still not returned to ARDC within 15 working days of Unit Manager notification, informs Unit Manager and copyholder that copyholder's document is no longer a controlled document.
	.10	Removes copyholder's name from document's controlled distribution list.
Unit Manager	.11	Ensures copyholder's document is returned to ARDC.

5.5 <u>Drawings</u>

Project Manager (PM)	.1	Communicates to support organizations, via Task Baseline Agreement (TBA) or similar work authorizing document, that all drawings developed within EG&G Idaho will be controlled by the Engineering Department per Engineering Standard Practice (ESP) 4.4.1 (Reference 4).
Support Organizations	.2	Obtain drawing number from ARDC.
	.3	Develop drawings which comply with the EG&G Idaho <u>Drawing Requirements Manual</u>. (Reference 5)
	.4	Submit drawings to PM for review and approval.
PM	.5	Designates appropriate reviews (e.g., Safety and Quality checker).
	.6	Ensures review(s) is conducted.

5.5 Drawings (continued)

Support Organization	.7	Revises drawings per comments received.
PM	.8	Ensures drawing approval in accordance with ERP PD 2.2.
	.9	Submits drawings to the Engineering Configuration Management (ECM) Unit of the Engineering Department with a distribution list and a completed Form EG&G-1217, Engineering Document Control Document Information Form (Appendix B).
ECM Unit Manager	.10	Ensures drawings are released as specified in Engineering Operating Procedure (OP)-142, "Release of Drawings and Change Control Documents" (Reference 6).

5.6 Vendor Drawings

Project Manager	.1	Identifies drawing submittal requirements on the Vendor Data Schedule Form IDF 4700.1D (Appendix B).
	.2	Submits the Vendor Data Schedule Form with the Inter-contractor Work Authorization, Form ID F-2100.A (Appendix B), and other work related documentation (i.e., technical specification, scope of work, Quality Program Plan) to the Construction Management (CM) organization for the Idaho National Engineering Laboratory (INEL).
	.3	Obtains drawings or other vendor data from Construction Manager.
PM	.4	Reviews and obtains required reviews per ERP PD 2.2.
	.5	Submits review comments to CM organization for resolution.
	.6	If corrections are adequate, approves drawing per ERP PD 2.2.

5.6 Vendor Drawings (continued)

PM (continued)

.7 Obtains as-built drawings from CM.

.8 Reviews as-builts for adequacy and determines which drawings will be maintained as "EG&G controlled" drawings.

.9 Submits vendor drawings to ECM Unit for inclusion in EG&G controlled document process.

ECM

.10 Releases vendor drawings into Engineering Document Control (EDC) system.

5.7 Change Control for Drawings

Organization identifying change

.1 Obtains Document Change Notice (DCN) (Form EG&G-1180).

.2 Obtains DCN number from ECM and makes drawing revisions per the EG&G Idaho Drawing Requirements Manual, Section 7. (Reference 7)

.3 Submits DCN and drawing to PM for review.

PM

.4 Reviews and approves changes as described in Section 5.5 of this PD.

5.8 Specifications

PM

.1 Reviews EG&G Idaho Specifications Preparation Manual (Reference 8) to determine applicable specification format.

.2 Obtains specification number from ERP ARDC.

.3 Develops or has the specification developed.

.4 Submits specification for review and approval per ERP PD 2.2.

.5 Submits approved specification to ARDC.

5.8 Specifications (continued)

ARDC .6 Releases and controls specification in accordance with this PD or the requirements in the SPM.

5.9 Specification Changes

PM .1 Revises specification as specified in Section 5.2 of this PD or the requirements of the SPM.

6. REFERENCES/BIBLIOGRAPHY

1. American Society of Mechanical Engineers (ASME), Quality Assurance Program Requirements for Nuclear Facilities, NQA-1, Supplement 6S-1, "Supplementing Requirements for Document Control."

2. Environmental Restoration Program, Program Directives, 4.4, "Producing ERP Reports."

3. Environmental Restoration Program, Program Directives, 2.2, "Internal and Independent Review of Documents."

4. EG&G Idaho, Inc., Engineering Standard Practice, 4.4.1, "Document Control."

5. EG&G Idaho, Inc., Drawing Requirements Manual, October 1987.

6. Engineering Document Control, Operating Procedure (OP)-142, "Release of Drawings and Change Control Documents."

7. EG&G Idaho, Drawing Requirements Manual, Section 7, "Drawing Revisions."

8. EG&G Idaho, Inc. Specifications Preparation Manual.

DOE Order 1324.2A, "Records Disposition."

DOE-ID Order 1324.2A, "Records Disposition."

EG&G Idaho, Inc., Quality Manual, QP-6, "Document Control."

EG&G Idaho, Inc., Quality Manual, QP-17, "Quality Records."

EG&G Idaho, Inc., Resource Manual, Section 10, "Documentation Systems."

EG&G Idaho, Inc., Specifications Preparation Manual.

6. REFERENCES/BIBLIOGRAPHY (continued)

Environmental Restoration Program, Configuration Management Plan.

Environmental Restoration Program, Management Plan for the EG&G Idaho Environmental Restoration Program, EG&G-WM-8676.

EG&G Idaho, Inc., Safety Manual, Section 2.4, "Independent Safety Review and Oversight Matrix."

Environmental Restoration Program, Program Directives, 5.11, "Requirement/Use of DOPs and SOPs."

Environmental Restoration Program, Records Management Plan, to be issued.

APPENDIX A

PROPOSED DOCUMENTS TO BE CONTROLLED BY ARDC

ERP - EG&G

- Abbreviated Sampling and Analysis Plans
- Baseline Risk Assessment - WAG 7
- Categorical Exclusions
- Closure Plans
- Community Relations Plan
- Configuration Management Plan
- Cost Account Plans
- Data Collection Quality Assurance Plans
- Data Management Plan
- Design Packages
- Detailed Operating Procedures
- Feasibility Study Report
- Guidance of Conducting Remedial Investigation/Feasibility Studies under CERCLA
  Remedial Investigation Report
- Drawings (Per PD 4.1)
- Engineering Design Files
- Engineering Specifications
- Environmental Assessments
- Environmental Checklists/ Categorical Exclusions
- Environmental Impact Statements
- Field Sampling Plans
- Groundwater Monitoring Plans
- Health and Safety Plan, plus addenda
- Implementation Program Management Plan

DOE-ID

- Interagency Agreement/Federal Facility Agreement
- Level "0" and "I" Schedules
- Environmental Restoration and Waste Management Five-Year Plan
- Current-Year Budget Document
- Program Management Plan
- Appendix I Advanced Acquisition or Assistance Plan
- Appendix II Test and Evaluation Plan
- Appendix III Environment, Safety, and Health Protection Implementation Plan
- Financial Plan
- Prioritization Plan
- Program Execution Guidance
- Activity Data Sheets
- Site-Specific Plans
- Annual Budget Submittal
- Field Office Current-Year Work Plan

APPENDIX A (continued)

PROPOSED DOCUMENTS TO BE CONTROLLED BY ARDC (continued)

<u>ERP - EG&G (continued)</u>

- Monitoring, Analysis, and Testing Plans
- Operating and Maintenance Manuals
- Operational Safety Requirements
- Program Directives
- Quality Assurance Project Plan
- Quality Program Plan
- RCRA Facility Investigation Report
- RCRA Facility Investigation Work Plan
- RCRA Feasibility Study
- Records Management Plan
- Remedial Investigation Report
- Remedial Investigation/Feasibility Study Work Plan
- Remedial Investigation/Feasibility Study
- Safety and Analysis Plans
- Sampling and Analysis Plans
- Safety Assessment
- Site Health and Safety Plan (Scoping)
- Standard Operating Procedures
- Summary Assessments
- Systems Engineering Management Plan
- Technical memorandum as defined by Unit Manager
- Work Plans
- Draft Regulatory documents as defined by managers

APPENDIX B

Document Revision Request (Form EG&G-1844)

Printing Request for Services (Form EG&G-95)

Engineering Document Control Document Information Form (Form EG&G-1217)

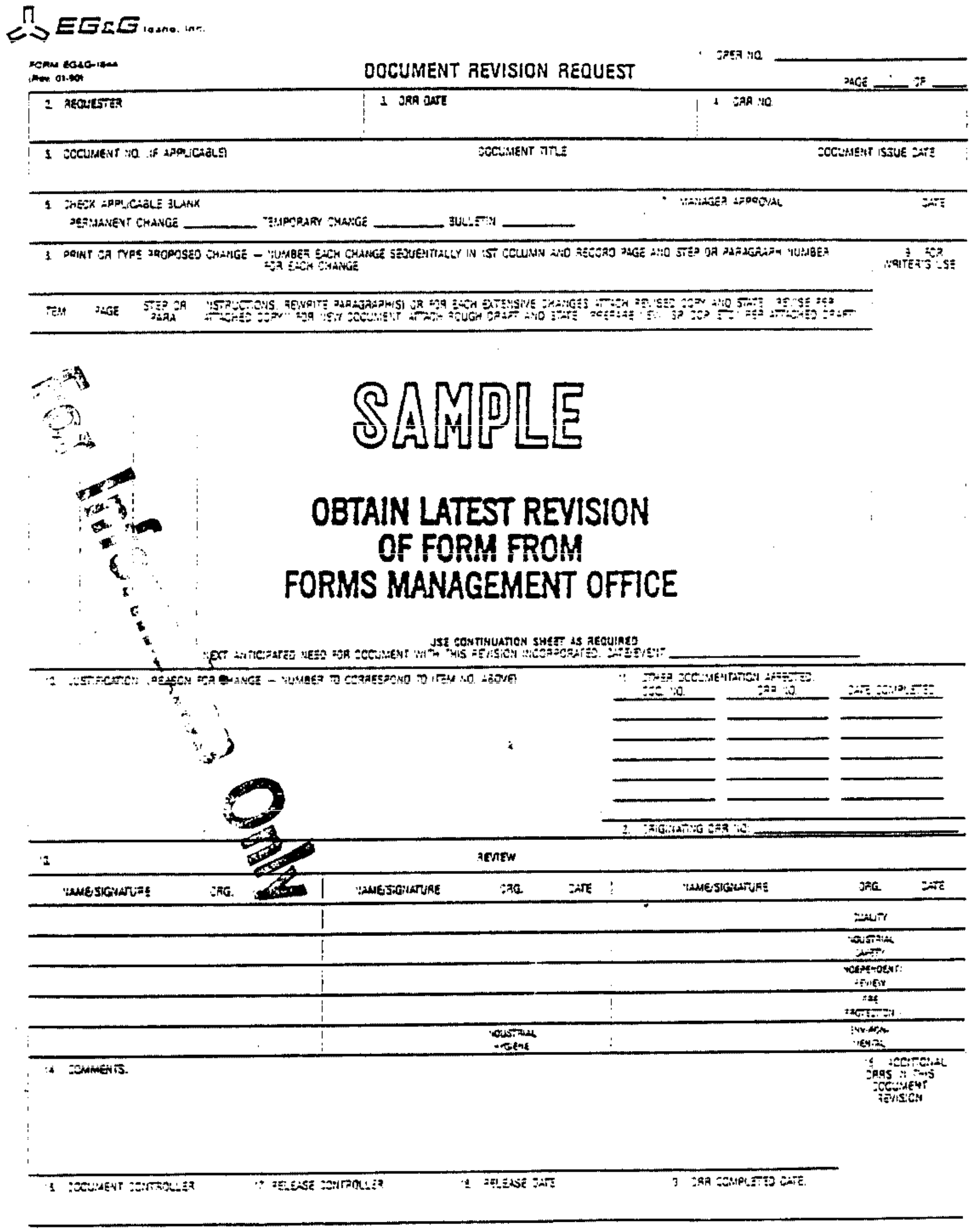
Vendor Data Schedule (Form IDF-4700.1D)

Inter-contractor Work Authorization (ID F-2100.A)

Drawing Change Form (Form EG&G-1180)

APPENDIX B (continued)

DOCUMENT REVISION REQUEST (Form EG&G-1844)



EG&G Idaho, Inc.

FORM EG&G-1844
(Rev. 01-90)

DOCUMENT REVISION REQUEST

1. OPER NO. ____________

PAGE ___ OF ___

2. REQUESTER

3. DRR DATE

4. DRR NO.

5. DOCUMENT NO. (IF APPLICABLE)

DOCUMENT TITLE

DOCUMENT ISSUE DATE

6. CHECK APPLICABLE BLANK
PERMANENT CHANGE ______ TEMPORARY CHANGE ______ BULLETIN ______

7. MANAGER APPROVAL

DATE

8. PRINT OR TYPE PROPOSED CHANGE — NUMBER EACH CHANGE SEQUENTIALLY IN 1ST COLUMN AND RECORD PAGE AND STEP OR PARAGRAPH NUMBER FOR EACH CHANGE

9. FOR WRITER'S USE

ITEM	PAGE	STEP OR PARA	INSTRUCTIONS: REWRITE PARAGRAPH(S) OR FOR EACH EXTENSIVE CHANGES ATTACH REVISED COPY AND STATE "REVISE PER ATTACHED COPY"; FOR NEW DOCUMENT ATTACH ROUGH DRAFT AND STATE "PREPARE [illegible] PER ATTACHED DRAFT"

SAMPLE

OBTAIN LATEST REVISION OF FORM FROM FORMS MANAGEMENT OFFICE

USE CONTINUATION SHEET AS REQUIRED

NEXT ANTICIPATED NEED FOR DOCUMENT WITH THIS REVISION INCORPORATED: DATE/EVENT ____________

10. JUSTIFICATION (REASON FOR CHANGE — NUMBER TO CORRESPOND TO ITEM NO. ABOVE)

11. OTHER DOCUMENTATION AFFECTED:

DOC. NO.	DRR NO.	DATE COMPLETED

12. ORIGINATING DRR NO. ____________

13. REVIEW

NAME/SIGNATURE	ORG.	DATE	NAME/SIGNATURE	ORG.	DATE	NAME/SIGNATURE	ORG.	DATE
							QUALITY	
							INDUSTRIAL SAFETY	
							INDEPENDENT REVIEW	
							FIRE PROTECTION	
				INDUSTRIAL HYGIENE			ENVIRON-MENTAL	

14. COMMENTS:

15. ADDITIONAL DRRS IN THIS DOCUMENT REVISION

16. DOCUMENT CONTROLLER

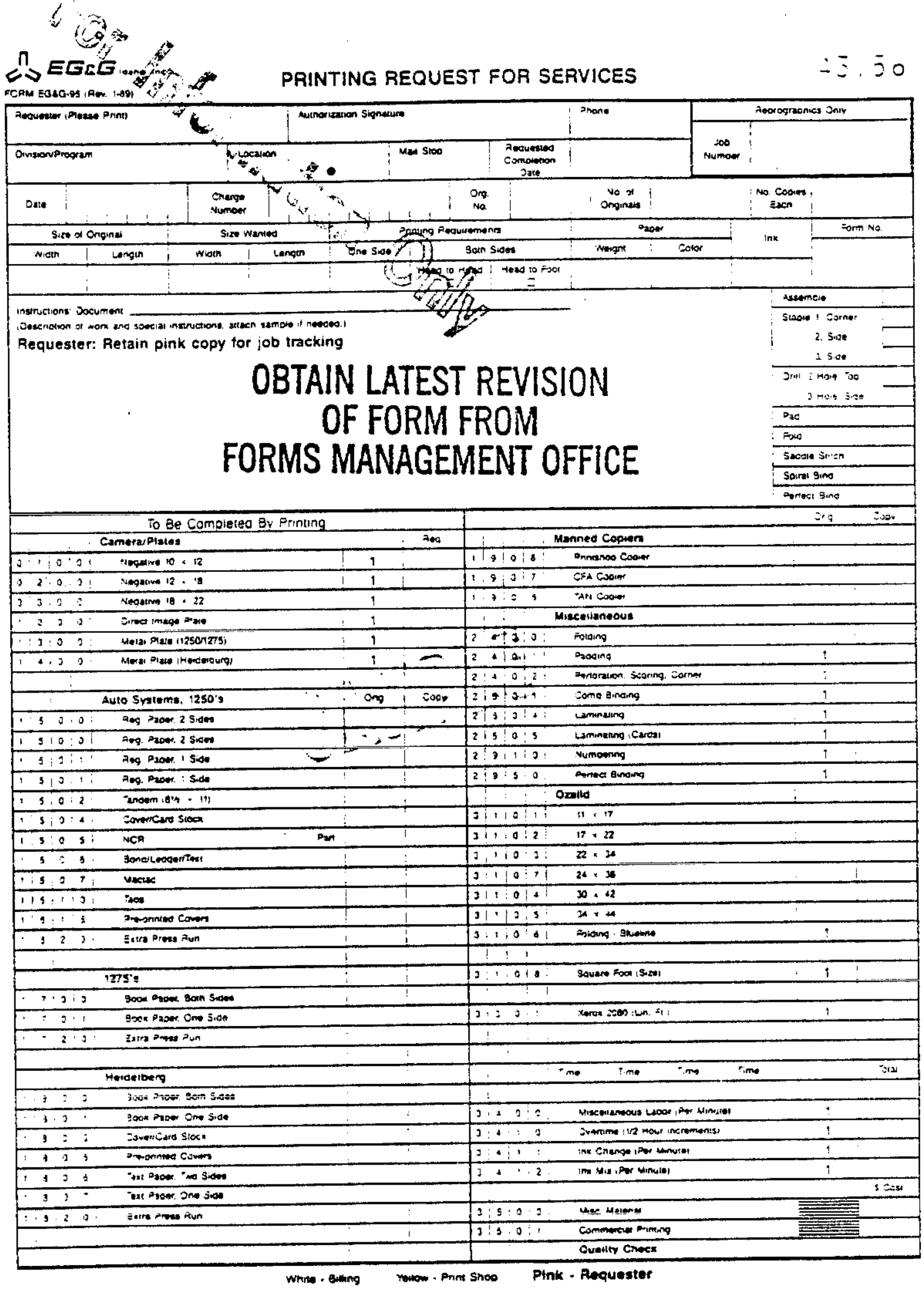
17. RELEASE CONTROLLER

18. RELEASE DATE

19. DRR COMPLETED DATE

APPENDIX B (continued)

PRINTING REQUEST FOR SERVICES (Form EG&G-95)



EG&G Idaho, Inc.
FORM EG&G-95 (Rev. 1-89)

PRINTING REQUEST FOR SERVICES

43.50

Requester (Please Print)	Authorization Signature	Phone	Reprographics Only Job Number
Division/Program	Location	Mail Stop	Requested Completion Date
Date	Charge Number	Org. No.	No. of Originals No. Copies Each

Size of Original		Size Wanted		Printing Requirements			Paper		Ink	Form No.
Width	Length	Width	Length	One Side	Both Sides		Weight	Color		
					Head to Head	Head to Foot				

Instructions: Document ____________________
(Description of work and special instructions, attach sample if needed.)

Requester: Retain pink copy for job tracking

OBTAIN LATEST REVISION OF FORM FROM FORMS MANAGEMENT OFFICE

Assemble	
Staple 1 Corner	
2. Side	
3. Side	
Drill 3 Hole Top	
3 Hole Side	
Pad	
Fold	
Saddle Stitch	
Spiral Bind	
Perfect Bind	

To Be Completed By Printing

	Camera/Plates	Req	
0 1 0 0	Negative 10 × 12	1	
0 2 0 0	Negative 12 × 18	1	
0 3 0 0	Negative 18 × 22	1	
1 2 0 0	Direct Image Plate	1	
1 3 0 0	Metal Plate (1250/1275)	1	
1 4 0 0	Metal Plate (Heidelburg)	1	
	Auto Systems, 1250's	Orig	Copy
1 5 0 0	Reg. Paper, 2 Sides		
1 5 0 0	Reg. Paper, 2 Sides		
1 5 0 1	Reg. Paper, 1 Side		
1 5 0 1	Reg. Paper, 1 Side		
1 5 0 2	Tandem (8½ × 11)		
1 5 0 4	Cover/Card Stock		
1 5 0 5	NCR Part		
1 5 0 6	Bond/Ledger/Text		
1 5 0 7	Mactac		
1 5 1 0	Tabs		
1 5 1 5	Pre-printed Covers		
1 5 2 0	Extra Press Run		
	1275's		
1 7 0 0	Book Paper, Both Sides		
1 7 0 1	Book Paper, One Side		
1 7 2 0	Extra Press Run		
	Heidelberg		
1 9 0 0	Book Paper, Both Sides		
1 9 0 1	Book Paper, One Side		
1 9 0 4	Cover/Card Stock		
1 9 0 5	Pre-printed Covers		
1 9 0 6	Text Paper, Two Sides		
1 9 0 7	Text Paper, One Side		
1 9 2 0	Extra Press Run		

		Orig	Copy
	Manned Copiers		
1 9 0 8	Printshop Copier		
1 9 0 7	CFA Copier		
1 9 0 5	TAN Copier		
	Miscellaneous		
2 4 3 0	Folding		
2 4 0 1	Padding	1	
2 4 0 2	Perforation, Scoring, Corner	1	
2 5 0 1	Comb Binding	1	
2 5 0 4	Laminating	1	
2 5 0 5	Laminating (Cards)	1	
2 9 1 0	Numbering	1	
2 9 5 0	Perfect Binding	1	
	Ozalid		
3 1 0 1	11 × 17		
3 1 0 2	17 × 22		
3 1 0 3	22 × 34		
3 1 0 7	24 × 36		
3 1 0 4	30 × 42		
3 1 0 5	34 × 44		
3 1 0 6	Folding - Blueline	1	
3 1 0 8	Square Foot (Size)	1	
3 3 0 1	Xerox 2080 (Lin. Ft.)	1	

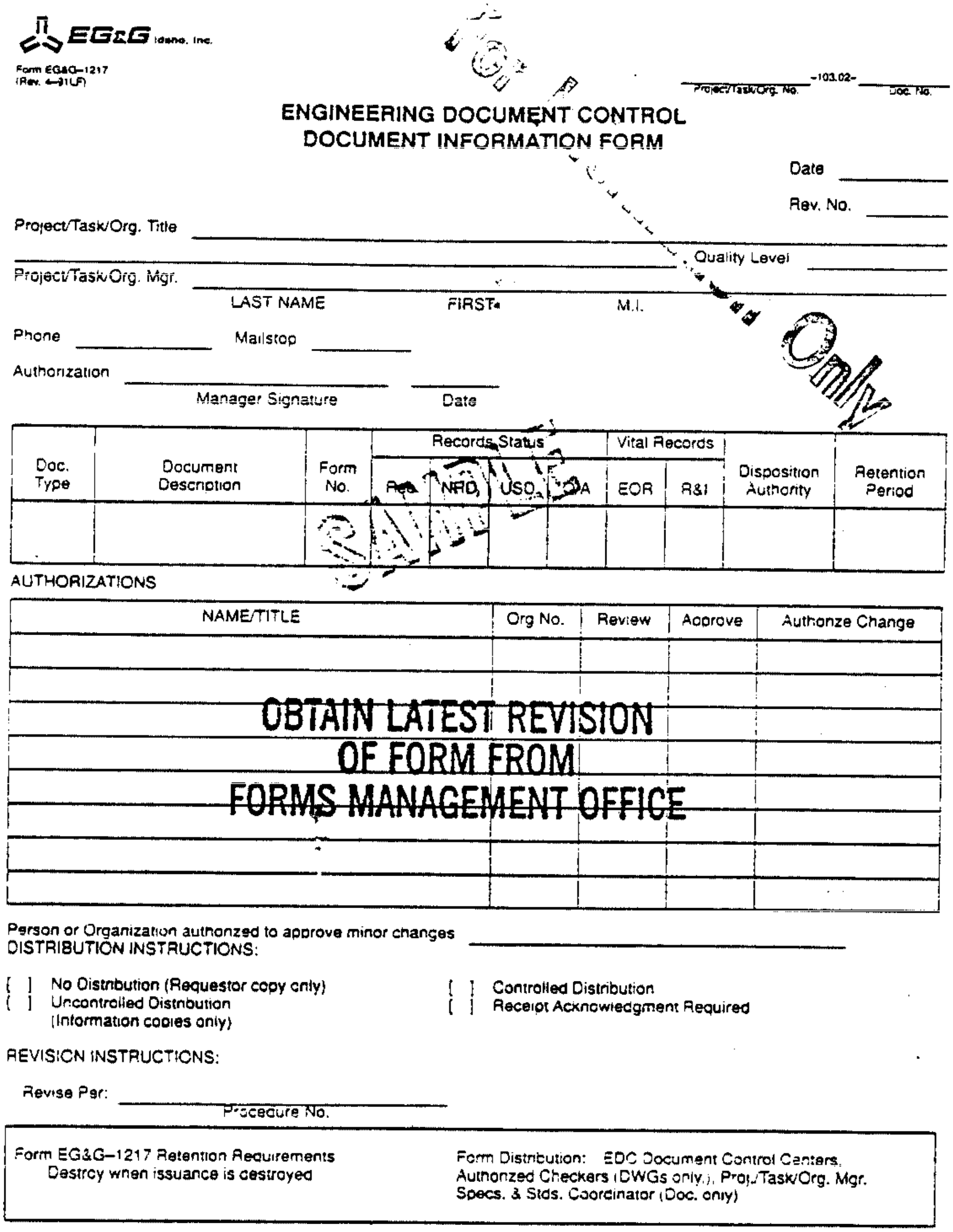
		Time	Time	Time	Time	Total
3 4 0 0	Miscellaneous Labor (Per Minute)					1
3 4 1 0	Overtime (1/2 Hour Increments)					1
3 4 1 1	Ink Change (Per Minute)					1
3 4 1 2	Ink Mix (Per Minute)					1

		$ Cost
3 5 0 0	Misc. Material	
3 5 0 1	Commercial Printing	
	Quality Check	

White - Billing Yellow - Print Shop **Pink - Requester**

APPENDIX B (continued)

ENGINEERING DOCUMENT CONTROL DOCUMENT INFORMATION FORM (Form EG&G-1217)



EG&G Idaho, Inc.
Form EG&G–1217
(Rev. 4–91LF)

_____ -103.02- _____
Project/Task/Org. No. Doc. No.

ENGINEERING DOCUMENT CONTROL
DOCUMENT INFORMATION FORM

Date _____

Rev. No. _____

Project/Task/Org. Title _____

Quality Level _____

Project/Task/Org. Mgr. _____
LAST NAME FIRST M.I.

Phone _____ Mailstop _____

Authorization _____ _____
Manager Signature Date

Doc. Type	Document Description	Form No.	Records Status				Vital Records		Disposition Authority	Retention Period
			Res	NRD	USQ	QA	EOR	R&I		

AUTHORIZATIONS

NAME/TITLE	Org No.	Review	Approve	Authorize Change

OBTAIN LATEST REVISION
OF FORM FROM
FORMS MANAGEMENT OFFICE

Person or Organization authorized to approve minor changes _____

DISTRIBUTION INSTRUCTIONS:

☐ No Distribution (Requestor copy only)
☐ Uncontrolled Distribution (Information copies only)
☐ Controlled Distribution
☐ Receipt Acknowledgment Required

REVISION INSTRUCTIONS:

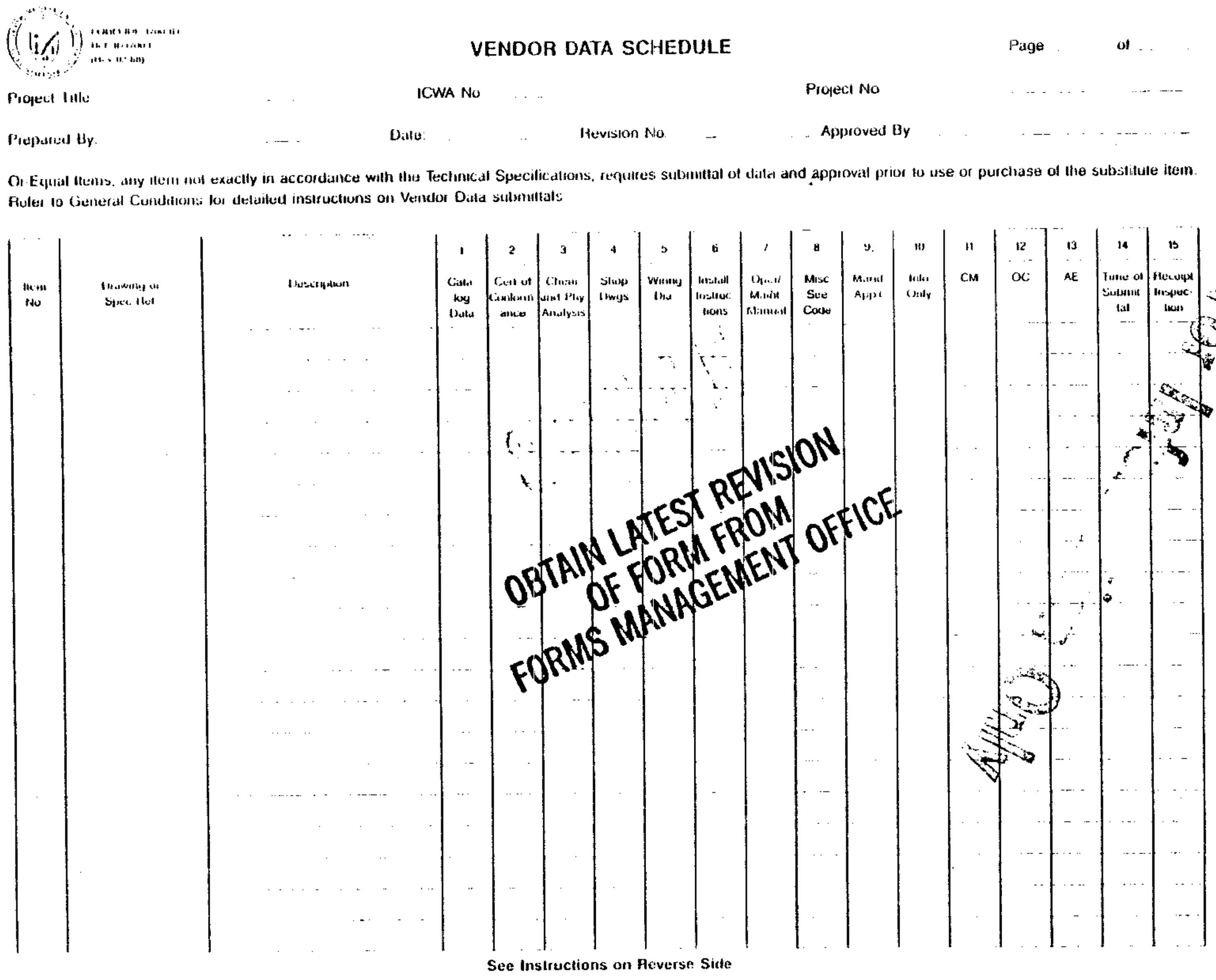
Revise Per: _____
Procedure No.

Form EG&G–1217 Retention Requirements
Destroy when issuance is destroyed

Form Distribution: EDC Document Control Centers, Authorized Checkers (DWGs only), Proj./Task/Org. Mgr. Specs. & Stds. Coordinator (Doc. only)

APPENDIX B (continued)

VENDOR DATA SCHEDULE (Form IDF-4700.1D)



VENDOR DATA SCHEDULE

Page ___ of ___

Project Title ___ ICWA No ___ Project No ___

Prepared By ___ Date ___ Revision No ___ Approved By ___

Or Equal Items, any item not exactly in accordance with the Technical Specifications, requires submittal of data and approval prior to use or purchase of the substitute item. Refer to General Conditions for detailed instructions on Vendor Data submittals

Item No	Drawing or Spec Ref	Description	1 Catalog Data	2 Cert of Conformance	3 Chem and Phy Analysis	4 Shop Dwgs	5 Wiring Dia	6 Install Instructions	7 Oper/Maint Manual	8 Misc See Code	9 Manuf Appr	10 Info Only	11 CM	12 OC	13 AE	14 Time of Submittal	15 Receipt Inspection

OBTAIN LATEST REVISION OF FORM FROM FORMS MANAGEMENT OFFICE

See Instructions on Reverse Side

APPENDIX B (continued)

VENDOR DATA SCHEDULE (Form IDF-4700.1D) (continued)

IDF-4700.1D
Rev 11-87

INSTRUCTIONS FOR IDF-4700.1D

COLUMN 1-8:	A number in one or more of these columns requires submittal of corresponding data and indicates the number of copies to be submitted.
COLUMN 8:	A letter entered in the miscellaneous column requires submittal of corresponding data in accordance with the list below

A. Sample (Color, Texture, Etc.)
B. Test Report
C. Design Calculation
D. Procedure/Instruction
E. Parts List
F. Piping Drawings
G. Assembly Drawings
H. Resume/Qualifications
I. Delivery Ticket
J. Unpriced POs
K. [illegible]sign
L. Material Safety Data Sheets
M. [illegible] Qualification Record
N. Welding Procedures

O

P

Q

COLUMN 9:	An "X" in this column indicates required data must be submitted and approved prior to use of the item.
COLUMN 10:	An "X" in this column indicates that submittal of data is required for information only. If the exact item specified is not used, Vendor Data must be submitted for Or-Equal Approval prior to use of the item.
COLUMNS 11, 12, 13:	An "X" in one of these columns indicates the agency authorized to approve corresponding required or Or-Equal Vendor Data.
COLUMN 14:	Codes listed below indicate the time by which the corresponding data must be approved. If column is not marked, refer to the General Conditions

WP	With Proposal
PTP	Prior to Purchase
BFR	Before Fabrication Release
PS	Prior to Shipment
WS	With Shipment
PTC	Prior to Construction Start
BU	Before Use
PT	Prior to Test
AT	After Test
BFA	Before Final Acceptance

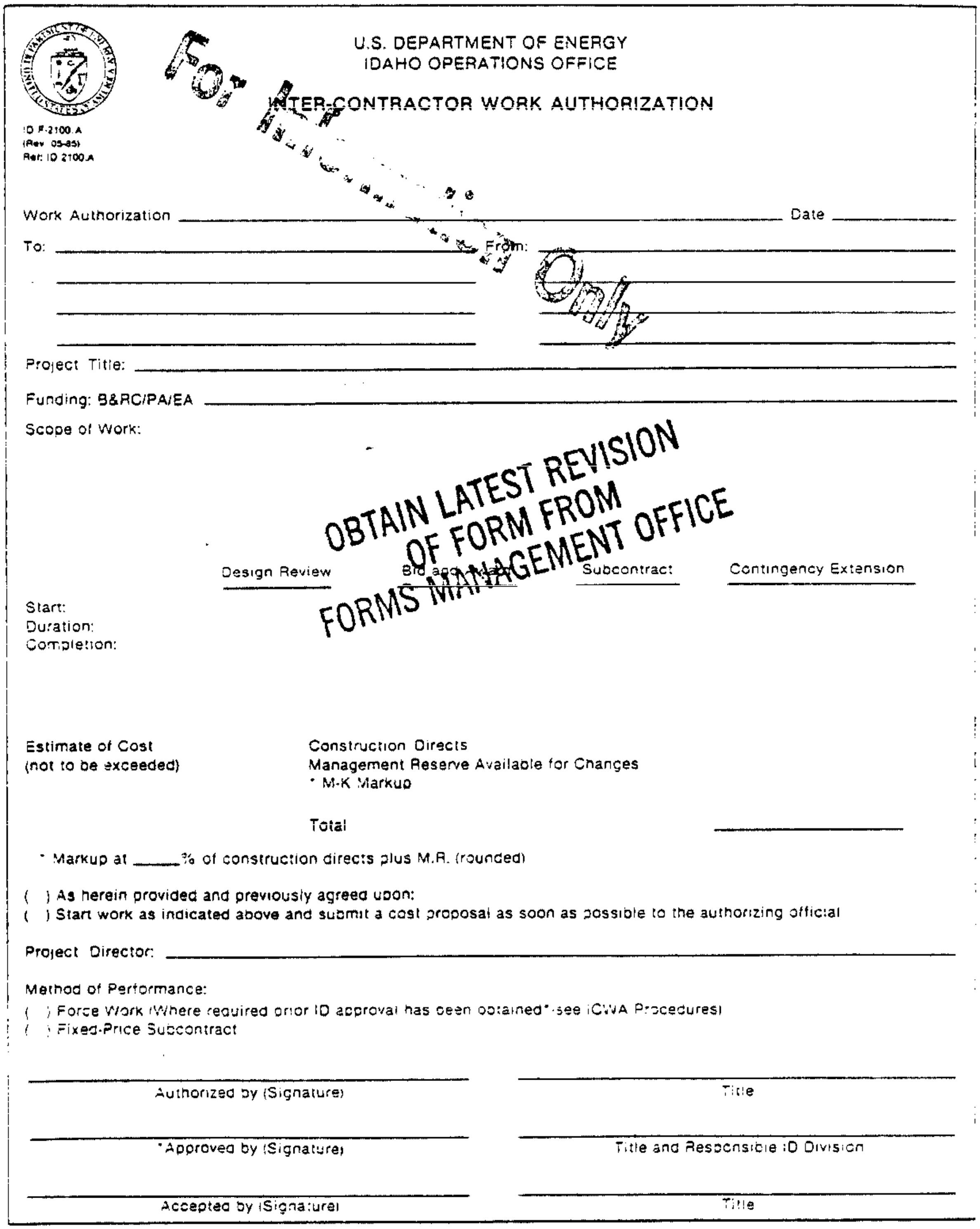
COLUMN 15:	An "X" in this column indicates that the item must be examined and approved by the inspection agency prior to use. Notify the contractor 24 hours prior to delivery.

OBTAIN LATEST REVISION
OF FORM FROM
FORMS MANAGEMENT OFFICE

Page 2

APPENDIX B (continued)

INTER-CONTRACTOR WORK AUTHORIZATION (ID F-2100.A)



ID F-2100.A
(Rev. 05-85)
Ref: ID 2100.A

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

INTER-CONTRACTOR WORK AUTHORIZATION

For [illegible] Only

Work Authorization ______________________________ Date __________

To: ______________________ From: ______________________

Project Title: ______________________________

Funding: B&RC/PA/EA ______________________________

Scope of Work:

OBTAIN LATEST REVISION
OF FORM FROM
FORMS MANAGEMENT OFFICE

	Design Review	Bid and Award	Subcontract	Contingency Extension
Start:				
Duration:				
Completion:				

Estimate of Cost
(not to be exceeded)

Construction Directs
Management Reserve Available for Changes
* M-K Markup

Total __________

* Markup at ______% of construction directs plus M.R. (rounded)

( ) As herein provided and previously agreed upon:
( ) Start work as indicated above and submit a cost proposal as soon as possible to the authorizing official

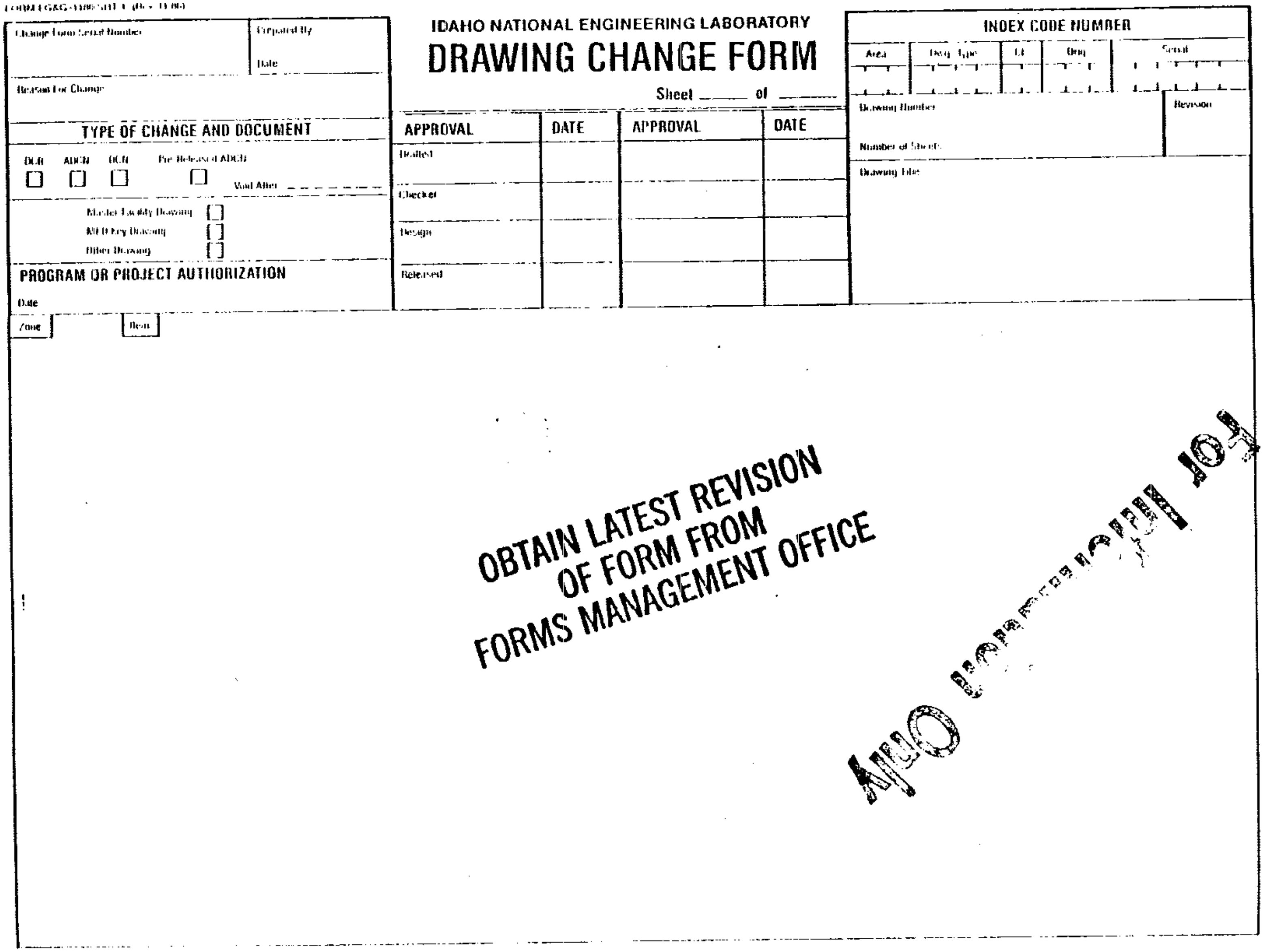
Project Director: ______________________________

Method of Performance:
( ) Force Work (Where required prior ID approval has been obtained*-see ICWA Procedures)
( ) Fixed-Price Subcontract

Authorized by (Signature)	Title
*Approved by (Signature)	Title and Responsible ID Division
Accepted by (Signature)	Title

APPENDIX B (continued)

DRAWING CHANGE FORM (Form EG&G-1180)



FORM EG&G-1180 [illegible]

IDAHO NATIONAL ENGINEERING LABORATORY

DRAWING CHANGE FORM

Sheet ____ of ____

Change Form Serial Number	Prepared By Date
Reason For Change	

TYPE OF CHANGE AND DOCUMENT

DCR ☐ ADCN ☐ DCN ☐ Pre-Released ADCN ☐ Void After ________

Master Facility Drawing ☐
INEL Key Drawing ☐
Other Drawing ☐

PROGRAM OR PROJECT AUTHORIZATION

Date

APPROVAL	DATE	APPROVAL	DATE
Drafter			
Checker			
Design			
Released			

INDEX CODE NUMBER

Area	Dwg. Type	Ct	Org	Serial

Drawing Number
Revision
Number of Sheets
Drawing Title

Zone
Item

OBTAIN LATEST REVISION OF FORM FROM FORMS MANAGEMENT OFFICE

For [illegible] Only

APPENDIX B (continued)

DRAWING CHANGE FORM (Form EG&G-1180) (continued)

FORM EG&G-1180-SHT 2 (Rev. 11-86)

DRAWING CHANGE FORM (CONT. SHEET)

INDEX CODE NUMBER

Area	Type	CI	Bldg	Serial

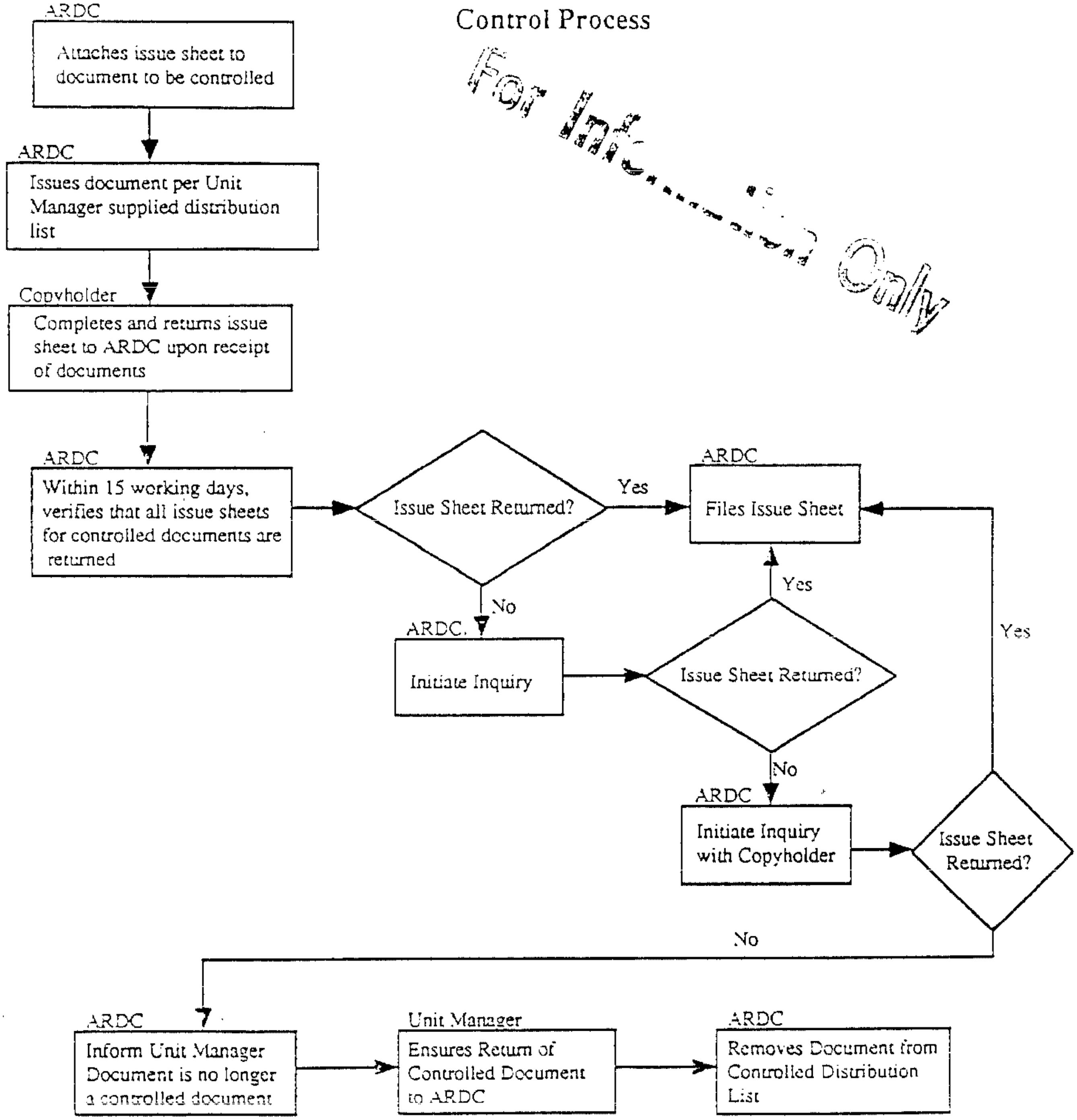
DCR ☐ ADCR ☐ DCN ☐	Date Prepared	ADCN/DCN Sheet	Checked	Drawing Number	Revision

Zone

Item

OBTAIN LATEST REVISION
OF FORM FROM
FORMS MANAGEMENT OFFICE

APPENDIX C


Control Process

Appendix L, Part 2
ERP-PD 4.2
Logbooks

EG&G Idaho, Inc. **PROGRAM DIRECTIVE** ENVIRONMENTAL RESTORATION PROGRAM	Title: LOGBOOKS	No.: PD 4.2 Page: 1 of 7 Date: 10/04/91
	Approved: Manager, ERP	Legend | = Change
Reviewed by: Original signatures appear on DRR# ERP-352, release date 10/03/91.		

1. PURPOSE AND SCOPE

This program directive (PD) defines requirements for use of logbooks controlled by Environmental Restoration Program (ERP) Field Data Coordinator.

2. ACRONYMS/DEFINITIONS

ARDC	--	Administrative Record and Document Control
ASAP	--	Abbreviated Sampling and Analysis Plan
COC	--	Chain of Custody
DOP	--	Detailed Operating Procedure
EPA	--	Environmental Protection Agency
ERP	--	Environmental Restoration Program
FTL	--	Field Team Leader
GW	--	Groundwater
MAT	--	Monitoring, Analysis, and Testing
PD	--	Program Directive
QA	--	Quality Assurance
QC	--	Quality Control
SAP	--	Sampling and Analysis Plan
SOP	--	Standard Operating Procedure

Characterization Plan: An abbreviated Sampling and Analysis Plan (ASAP); Sampling and Analysis Plan (SAP) [PD 5.2 (Reference 1)]; Monitoring Analysis, and Testing (MAT) Plan [PD 3.3 (Reference 2)]; or Groundwater (GW) Monitoring Plan [PD 3.3 (Reference 2)].

3. POLICY/PROCEDURE |

3.1 ERP Logbooks shall contain all data, activities, references to procedures, and observations necessary to reconstruct the activity being recorded. Reference shall be made to other logbooks (i.e., operations, inspections) maintained by other organizations in support of other ERP activities, as required by the Field Team Leader (FTL). |

3.2 Logbooks shall be bound in a manner that prevents easy removal of pages. Pages of logbooks shall be sequentially numbered.

3. POLICY/PROCEDURE (continued)

3.3 Project logbooks are the property of ERP, regardless of the performing organization. Requesters shall obtain unused logbooks and an associated control number from Administrative Record and Document Control (ARDC) Field Data Coordinator and return used logbooks to the ARDC Field Data Coordinator.

3.4 The logbooks designated for project use shall be listed in the Characterization Plan.

3.5 The FTL is responsible for ensuring project information is recorded in the appropriate logbook. Recordable information may include, but is not limited to, field work documentation, field instrumentation readings, calculations, calibration records, photograph references, sample tag/label numbers, meeting information, and relevant times and dates of telephone conferences, correspondence, or deliverables.

4. REQUIREMENTS

4.1 Administration of Logbooks

FTL	.1	Reviews list of available logbooks; requests needed logbooks from ARDC Field Data Coordinator.
	.2	If documentation requirements for the project are not satisfied by existing logbooks, provides ARDC Field Data Coordinator with master pages for new logbook.
ARDC Field Data Coordinator	.3	If master pages for a new logbook are received, initiates process of creating new logbook to meet project specifications.
	.4	Ensures that logbooks are bound and pages numbered sequentially.
	.5	Provides FTLs with logbooks and an assigned control number for each logbook.
FTL	.6	Receives appropriate logbooks from the ARDC Field Data Coordinator before initiating a sampling activity.

4.1 Administration of Logbooks (continued)

FTL (continued)

.7 Returns logbooks to the ARDC Field Data Coordinator at a time agreed upon between the FTL and ARDC Field Data Coordinator.

ARDC Field Data Coordinator

.8 Files project logbooks and ensures the record storage requirements of PD 1.9 (Reference 3).

4.2 Use of Logbooks

Personnel using logbooks

.1 Ensure minimum requirements for common logbooks found in Appendix A of this PD are met. Specific instructions for the use of other logbooks listed in Appendix A shall be obtained from the ARDC Field Data Coordinator.

.2 Apply the following for all logbooks:

a. Use nonsmearable, waterproof ink.

b. Write legibly.

c. Correct errors in logbook by drawing a single line through the error (The erroneous information shall not be obliterated.) and writing the correct information next to the error. The individual making the correction shall initial and date the correction.

d. Avoid writing information in the margins of field logbooks.

e. Ensure all signatures and dates are completed for each page as required.

f. Protect logbooks against damage, deterioration, or loss.

4.2 Use of Logbooks (continued)

Personnel using logbooks (continued)

g. Prevent contamination of logbooks when working in a high risk area by recording comments in a separate bound and numbered logbook and transferring information to the appropriate project logbook. The original records shall be retained (if not contaminated) per this PD, and the transferred information shall be noted as such.

h. Draw an "X" over any blank space remaining at the bottom of logbook pages to indicate when entries are complete.

5. REFERENCES

1. Environmental Restoration Program, Program Directives, 5.2, "Preparation of Sampling and Analysis Plans."
2. Environmental Restoration Program, Program Directives, 3.3, "Writing Monitoring, Analysis, and Testing Plans and Groundwater Monitoring Plans for COCA Sites."
3. Environmental Restoration Program, Program Directives, 1.9, "Records Management."
4. Environmental Restoration Program, Program Directives, 5.7, "Chain-of-Custody Record."

APPENDIX A

REQUIREMENTS OF COMMONLY USED ERP LOGBOOKS

Logbooks have specific provisions required by Environmental Protection Agency (EPA), ERP, and/or field sampling teams.

1. <u>Sample Logbook</u>

FTL and Field Samplers	.1	Maintain a Sample Logbook during a sampling project.
Field Samplers	.2	Record the following information when applicable: sampling location, depth or depth interval, field personnel, document numbers of Standard Operating Procedures (SOPs) and/or Detailed Operating Procedures (DOPs), types and numbers of samples collected, collection method, time and date of sample collection, type and preparation of sample bottles, preservation of samples, field measurement data, field instrument calibration checks, weather conditions, ambient temperature, barometric pressure, any observations about conditions or incidents affecting sampling activities and/or sample quality, preparation and submission of field Quality Control (QC) samples, Work/Quality Assurance (QA) Plan number, and any deviations from the characterization plan used for the project, as appropriate.
	.3	Sign and date entries immediately after concluding each sampling activity.
FTL or designee	.4	Signs and dates the logbook immediately after concluding each sampling activity.
FTL	.5	Reviews, initials, and dates each page daily.

APPENDIX A (continued)

1. Sample Logbook (continued)

FTL (continued)

.6 Ensures that the names of the field team members are recorded in the Sample Logbook for each location sampled.

2. Field Team Leader's Daily Logbook

FTL

.1 Maintains a Field Team Leader's Daily Logbook or equivalent ERP logbook during a sampling/data collection activity to provide a daily record of events, observations, and measurements during field investigations. The purpose of this logbook is to report information on field activities when sampling/data collection activities are being performed.

.2 Records Industrial Hygiene monitoring data form number from Form EG&G-737 project information including, but not limited to, field work documentation, photograph references, meeting information, times and dates of important telephone conferences, correspondence, and deliverables.

.3 Ensures signatures of field team workers are recorded in the logbook next to the printed name of each field team worker.

.4 Ensures names of visitors during field activities are recorded in this logbook or in a separate site logbook. All entries shall be signed and dated.

3. Calibration Logbook

Health Physics Technician or Field Sampling Team Member

.1 Maintains a Calibration Logbook with entries, as appropriate, for each piece of equipment and instrument that requires calibration.

.2 Records the time, method, results, and name of individual performing the calibration.

APPENDIX A (continued)

4. Sample Shipping Logbook

FTL or designee	.1 Records date each sample is sent to a laboratory, name of laboratory, cooler number (if appropriate), chain-of-custody (COC) number (Reference 4), and the sample shipping classification (EPA or Department of Transportation).
	.2 Ensures each page is signed and dated as required.

Appendix L, Part 3
ERD-PD 5.7, Chain-of-Custody Record

EG&G Idaho, Inc. **PROGRAM DIRECTIVE** ENVIRONMENTAL RESTORATION PROGRAM	Title: CHAIN-OF-CUSTODY RECORD	No.: PD 5.7 Page: 1 of 11 Date: 06/17/91
	Approved: Manager, ERP	Legend │ = Change

Reviewed by:
Original signatures appear on DRR# ERP-298, release date 06/14/91.

1. PURPOSE AND SCOPE

This program directive (PD) provides the Chain-of-Custody (COC) procedure for all samples collected during field sampling activities for the Environmental Restoration Program (ERP).

2. ACRONYMS/DEFINITIONS

ARDC	--	Administrative Record and Document Control
ASAP	--	Abbreviated Sampling and Analysis Plan
CERCLA	--	Comprehensive Environmental Response, Compensation, and Liability Act
COC	--	Chain of Custody
DOE	--	Department of Energy
DOT	--	Department of Transportation
ERP	--	Environmental Restoration Program
GW	--	Groundwater
IAG	--	Interagency Agreement
MAT	--	Monitoring, Analysis, and Testing
PD	--	Program Directive
QA	--	Quality Assurance
RCRA	--	Resource Conservation and Recovery Act
SAP	--	Sampling and Analysis Plan
SOW	--	Statement of Work

<u>COC Form</u>: Record to document the transfer of sample custody.

<u>COC Procedure</u>: Procedure to document sample custody from the time each is collected until analysis is complete and any residue is disposed.

<u>Characterization Plan</u>: An abbreviated Sampling and Analysis Plan (ASAP); Sampling and Analysis Plan (SAP) [(PD 5.2) (Reference 1)]; Monitoring, Analysis, and Testing (MAT) Plan [(PD 3.3) (Reference 2)]; or Groundwater (GW) Monitoring Plan [(PD 3.3) (Reference 2)].

<u>Custody</u>: A sample is considered in custody if it:

- Is in one's possession
- Is in one's view after being in possession
- Was in possession and is now locked up
- Is in a designated secured area.

2. ACRONYMS/DEFINITIONS (continued)

Evidence: Anything offered at the time of a legal proceeding as a means of ascertaining the truth. In investigations involving hazardous wastes, physical and documentary evidence is collected to determine if the site poses a potential threat to human health or the environment and/or if the site complies with applicable regulations.

Properly Sealed Shipping Container: Any shipping container which has two custody seals applied to opposite sides of the shipping container top, over which is placed clear plastic tape, and is taped shut, preferably with fiberglass tape.

Sample: Any physical evidence collected from an environmental measuring or monitoring activity.

Sample Custodian: Person who is responsible for sample custody.

Sampler: Person who collects samples.

3. POLICY

Implementation of this PD meets the requirements of the Resource Conservation and Recovery Act (RCRA) [Section 3007(a)(2)] Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Section 104) and INEL Interagency Agreement (IAG). An ERP COC Form (EG&G Form 114) (Appendix A) is the preferred form to be used to track sample custody from the time of collection through laboratory analysis until it reaches its final destination. Every person who transfers custody of samples is responsible for timely and accurate completion of the COC form.

4. PROCEDURE/REQUIREMENTS

Sample Custodian	.1	Completes information required for each sample to be shipped on the COC form (e.g., Form EG&G 114). Records and identifies all samples to be shipped on COC Form EG&G 114 as indicated in Appendix A.

NOTE: Quality Assurance (QA) samples (e.g., field blanks, field duplicates, equipment rinsates, spiked matrices, trip blanks) should not be indicated in the remarks portion of the COC form. QA samples must be submitted blind to the laboratory performing the analyses.

4. REQUIREMENTS (continued)

Sample Custodian (continued) NOTE: (continued) Administrative Record and Document Control (ARDC) document number of the Characterization Plan should be included on the COC form. The ERP Statement of Work (SOW) number under which the samples will be analyzed must be entered on each COC form.

.2 Signs, dates, and notes the time on the COC form when transferring custody of the samples.

.3 Retains the green copy or photocopy of the COC form in the working project file. Sends the pink carbon copy of the COC form to ARDC.

.4 Ensures that an original COC form accompanies each shipment container.

Either .5 When shipping nonhazardous, nonradioactive samples on-site, arranges delivery of samples to receiving location;

or When shipping nonhazardous, nonradioactive samples off-site, fills out a Request for Shipment of Materials (Form EG&G-176) (Appendix B) and arranges delivery of shipment to Shipping and Receiving;

or When shipping hazardous and/or radioactive samples on-site or off-site, fills out a Request for Shipment of Materials (Form EG&G-176) and a U.S. DOE Off-Site Radioactive Material Shipment Record (Form ID F 5480.1A) (Appendix C); arranges for a qualified transporter (an equipment operator) to deliver shipment to receiving location or Shipping and Receiving.

4. REQUIREMENTS (continued)

Sample Custodian (continued)

NOTE: Every person who transfers custody of samples is responsible for timely and accurate completion of the COC form, except the following personnel when handling a properly sealed shipping container: a qualified transporter (an equipment operator) who has signed the ID F 5480.1A form accompanying the shipment; Shipping and Receiving personnel who receive the shipping container prior to delivery to a transport carrier; and transport carrier personnel (e.g., express carriers). In each case, COC can be tracked by the documentation required for shipment [e.g., Forms EG&G-176, ID F 5480.1A, and EG&G-361 ("Shipping Document") (Appendix D), and transport carrier shipping papers].

.6 Instructs shipping personnel to complete the Shipping Document (Form EG&G-361) with (a) number of coolers shipped, (b) project title, and (c) the COC form numbers present in the coolers shipped.

Field Team Leader

.7 Ensures laboratory COC requirements are followed as stated in ERP PD 5.5 Appendix A (Reference 3).

ARDC Field Data Coordinator

.8 Logs in and files COC forms for future retrieval.

5. REFERENCE/BIBLIOGRAPHY

1. Environmental Restoration Program, <u>Program Directives</u>, 5.2, "Preparation of Sampling and Analysis Plans."

2. Environmental Restoration Program, <u>Program Directives</u>, 3.3, "Writing Monitoring, Analysis, and Testing Plans and Groundwater Monitoring Plans for COCA Sites."

3. Environmental Restoration Program, <u>Program Directives</u>, 5.5, "Obtaining Laboratory Services."

5. REFERENCES/BIBLIOGRAPHY (continued)

EG&G Idaho, Inc., Quality Program Plan for the Environmental Restoration Program, QPP-149.

Environmental Restoration Program, Program Directives, 2.4, "Characterization Process in the Environmental Restoration Program."

Environmental Restoration Program, Program Directives, 5.6, "Conducting Audits."

APPENDIX A

EXAMPLE OF A CHAIN-OF-CUSTODY FORM

EG&G Idaho, Inc.

EG&G FORM 314 (Rev. 04-90)

ENVIRONMENTAL RESTORATION PROGRAM CHAIN OF CUSTODY FORM

Page ________ of ______

Sampler: (Signature)	Sample Custodian: (Signature)	Project Name

Sampling & Analysis Plan #

Sample No.	Sample Date	Sample Time	Comp	Grab	Sample Location	Aqueous	Solid	Gamma	Metals	Volatiles	Semi Volatiles									Remarks

SAMPLE

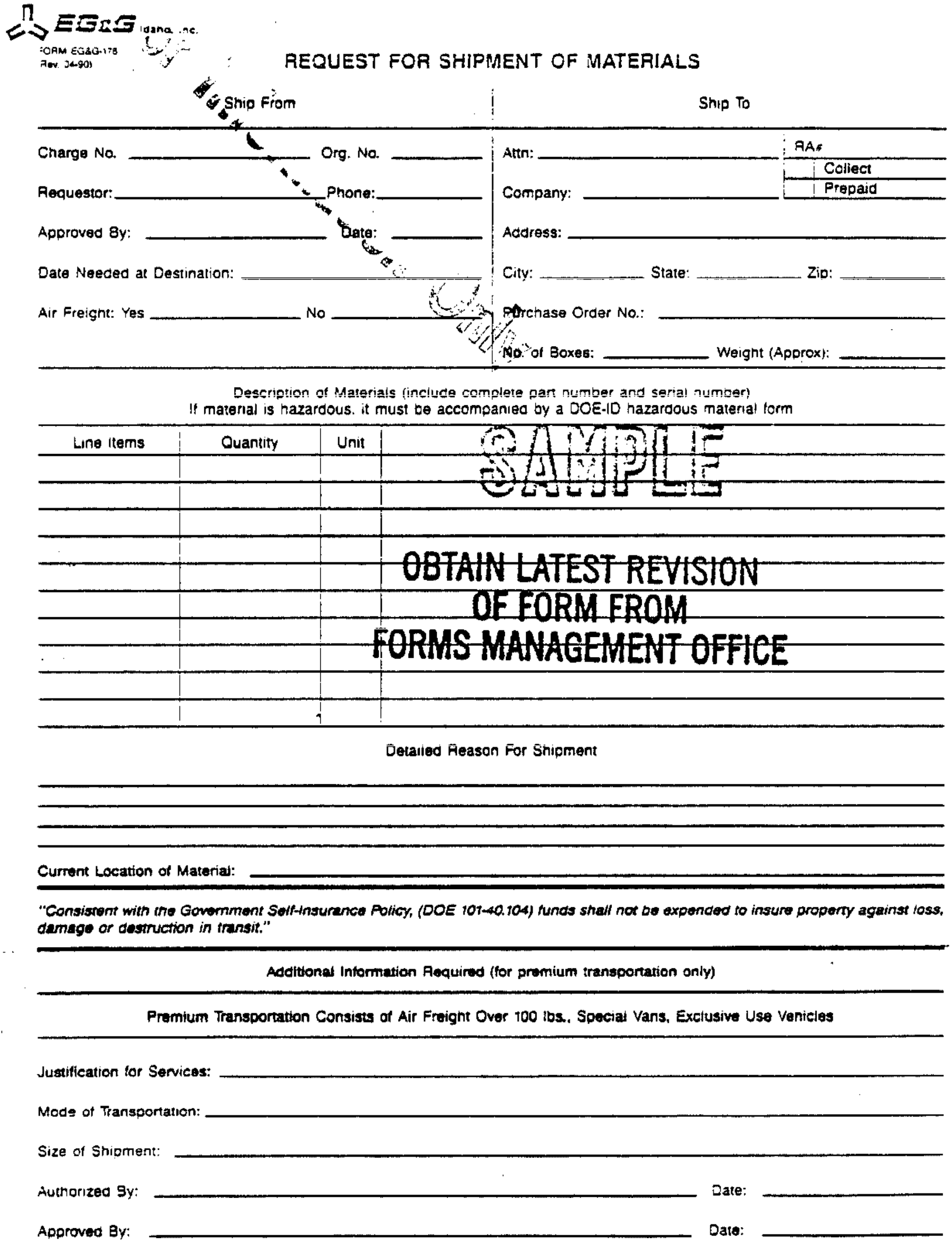
OBTAIN LATEST REVISION
OF FORM FROM
FORMS MANAGEMENT OFFICE

Special Instructions:

Relinquished by: (Sig.)	Received by: (Sig.)	Date	Time	Relinquished by: (Sig.)	Received by: (Sig.)	Date	Time

DISTRIBUTION: Original & Yellow. Accompany shipment to laboratory. Original Returned by Custodian. Pink. Forward to Administrative Records and Document Control. Green. Retained by Samplers.

APPENDIX B
REQUEST FOR SHIPMENT OF MATERIALS



EG&G Idaho, Inc.
FORM EG&G-178
Rev. 04-90)

REQUEST FOR SHIPMENT OF MATERIALS

Ship From	Ship To
Charge No. ________ Org. No. ________	Attn: ________ RA# ________
Requestor: ________ Phone: ________	Company: ________ ☐ Collect ☐ Prepaid
Approved By: ________ Date: ________	Address: ________
Date Needed at Destination: ________	City: ________ State: ________ Zip: ________
Air Freight: Yes ________ No ________	Purchase Order No.: ________
	No. of Boxes: ________ Weight (Approx): ________

Description of Materials (include complete part number and serial number)
If material is hazardous, it must be accompanied by a DOE-ID hazardous material form

SAMPLE

Line Items	Quantity	Unit	

OBTAIN LATEST REVISION
OF FORM FROM
FORMS MANAGEMENT OFFICE

Detailed Reason For Shipment

____

Current Location of Material: ________

"Consistent with the Government Self-Insurance Policy, (DOE 101-40.104) funds shall not be expended to insure property against loss, damage or destruction in transit."

Additional Information Required (for premium transportation only)

Premium Transportation Consists of Air Freight Over 100 lbs., Special Vans, Exclusive Use Vehicles

Justification for Services: ________

Mode of Transportation: ________

Size of Shipment: ________

Authorized By: ________ Date: ________

Approved By: ________ Date: ________

APPENDIX B (continued)

INSTRUCTIONS FOR FORM EG&G-176

---

1. The requestor is responsible for initiating the Request for Shipment of Materials form. Provide instructions to the consignee as to the identification, use and disposal of the material. Provide charge numbers for labor to cover efforts involved in the inspection of packaging, preservation and shipment of the materials. Insure proper paperwork, packaging, and data accompany the shipment. All shipments are shipped from CFA 601.
2. If a shipment involves hazardous materials, it is the requestors responsibility to insure that the proper containers and forms are used. The DOE-ID hazardous material shipping form is required in addition to the form 176.
3. Traffic is responsible for inspection of materials for shipment from the INEL and to adhere to requirements furnished by the requestor.
4. Traffic is responsible for coordinating the shipment of materials, making shipping arrangements, completing bills of lading for shipments originating at the INEL and releasing shipments originating outside the INEL.
5. After Request for Shipment is approved, Traffic shall complete shipping arrangements, prepare the bill of lading and a form EG&G-361, Shipping Document, and ship the material.

For those shipments requiring Premium Transportation,
please complete "ADDITIONAL INFORMATION REQUIRED"
at the bottom of the front page in detail

**OBTAIN LATEST REVISION
OF FORM FROM
FORMS MANAGEMENT OFFICE**

APPENDIX C
US DOE OFF-SITE RADIOACTIVE MATERIAL SHIPMENT RECORD

ID F 5480.1A
(Rev. 07-83)

US DOE OFF-SITE RADIOACTIVE MATERIAL SHIPMENT RECORD

Shipment From: ______________________

Log No. ______________________

References:
DOE 5480.1A Chap III.
49 CFR 100-199

OBTAIN ~~LATEST REVISION~~
~~OF FORM FROM~~
~~FORMS MANAGEMENT OFFICE~~

Originator

To ______________________

Charge No. ______________ Collect ☐ Prepaid ☐

Carrier(s) ______________________

Sole Use ☐ INEL Long Haul ☐ Other ☐

Consignee is Authorized to Receive Shipment ☐

Consignee Notified ☐ Date ______________

Material(s): (Proper DOT Shipping Name)

Chemical Form: ______________

Weight ______________ Vol. ______________

Container Used (describe): ______________

DOT Identification No. ______________

Physical Form: Solid ☐ Liquid ☐ Gas ☐

Type of shipment

Packaging:

Principal Nuclide(s)	Curies (Ci)

Total Curies ______________

Limited Quantity ☐
Rad. Article ☐
A_1 ☐ A_2 ☐
Greater than:
A_1 ☐ A_2 ☐
Highway Route Controlled ☐
LSA ☐
Empty ☐

Industrial ☐
DOT Spec. ______________
Type A ☐ B ☐ B(U) ☐ B(M) ☐
C of C No. ______________
Size ______________
Weight ______________
Transport Index ______________
Other ______________

ONLY

Seal No.(s) ______________

FISSILE MATERIALS: Not Applicable ☐ Fissile Shipment ☐ Fissile Exempt ☐

Fissile Materials: U ______ ______ gms Pu ______ ______ gms Other ______ ______ gms

Fissile Exempt ☐ Class I ☐ Class II ☐ Trans. Index ______________

Class III ☐ Controls: ______________

(No more than ______ packages may be loaded on any vehicle or storage location)

ACCOUNTABLE NUCLEAR MATERIALS: Not Applicable ☐ Applicable ☐

DOE/NRC F 741 No. ______________ Remarks: ______________

Health and Safety

Tie-downs Adequate ☐ Remarks: ______________

Radiation: (surface) ______ mrem/hr (3 feet) ______ mrem/hr

Contamination: (Averaged over any 300 cm² Package Surface)

Beta-Gamma ______________ dis/min/100 cm²

Alpha ______________ dis/min/100 cm²

Additional Surveys: Vehicle ☐ Driver ☐ Other ______________

Remarks: ______________

LABELS

None Required ☐ White I ☐
Yellow II ☐
Yellow III ☐
Pelegro ☐
Empty ☐
Other(s) ______________

Signatures

Loader: ______________ Date ______
Seal Applicator: ______________ Date ______
Safety Insp.: ______________ Date ______
Criticality Safety: ______________ Date ______
Rad. Surveyor: (Package(s)) ______________ Date ______
(Driver and Vehicle) ______________ Date ______
(Fissile and/or Accountable Nuclear Material only)
Safeguards Rep.: ______________ Date ______
Security Rep. ______________ Date ______

VEHICLE PLACARD(s)

None Required ☐
Radioactive ☐
Highway Route Controlled ☐
Other(s) ______________

This is to certify that the above-named materials are properly classified, described, packaged, marked, and labeled, and in proper condition for transportation according to the applicable regulations of the Department of Transportation and DOE ☐

Originator: ______________ Date ______ Area Supervisor ______________ Date ______

Trans

Carrier Rep. ______________ Date ______________

Traffic Agent ______________ Organization ______________ Date Released ______________

(DIRECTIONS ON REVERSE SIDE)

APPENDIX C (continued)

INSTRUCTIONS FOR COMPLETION OF ID F 5480.1A

GENERAL

1. All entries must be completed with either the appropriate information or the abbreviation of "not applicable" (N/A).
2. Where a selection is made from several choices in a group (e.g., Mode of Transport), that selection negates the need to use N/A for the remainder.
3. Each section of the form (Originator, Health and Safety, Signatures, etc.) must be completed in accordance with 1. above.
4. The individual signing authenticates the accuracy and validity of all information pertinent to the activity.

SPECIFIC

Most of the selections are self-explanatory; however, the following brief explanations may be helpful:

1. Originator

    a. Materials shipped - use proper shipping name(s) in accordance with 49 CFR part 172 (para. 172.101).
    b. Physical Form.—
    A_1 - Special Form - solid or encapsulated as defined in 49 CFR Para. 173.403(a).
    A_2 - Radioactive materials that do not qualify as Special Form and are generally dispersable. This designation is defined in 49 CFR Para. 173.403(b).

    c. Packaging -

    Industrial - used for less than A_1 or A_2 quantities and in accordance with 49 CFR 173.421.
    C of C - Certificate of Compliance issued for Type B containers.
    B(M) and B(U) - packaging used for international shipments as defined in 49 CFR 173.401(ee) and (ff), respectively.

    d. Fissile - (49 CFR 173.451)

    (1) Fissile Materials: Uranium-233, Uranium-235, Plutonium-238, Plutonium-239, Plutonium-241, Neptunim-237, and Curium-244.
    (2) Fissile exempt - less than 15 grams or in accordance with 49 CFR 173.453.
    (3) Transport Index - used for Fissile Class II in accordance with 49 CFR 173.403(bb) or Cert. of Comp.
    (4) Fissile Class III - require listing controls and maximum number of these pkgs. permitted for the transport vehicle or storage location.

    e. Accountable Nuclear Materials indicate the presence of any of the following materials: Uranium, Plutonium, Californium, Neptunium, Thorium, Tritium, Berkelium, Americium, Lithium (enriched), Deuterium, and Curium.

    (1) ID Facilities: Applicable to materials greater than two nanocuries per gram matrix.
    (2) NRF and ANL-W: Applicable to any quantity of accountable nuclear material.

    f. Type of shipment

    (1) Limited Quality - as defined in 49 CFR 173.421.
    (2) LSA -Low Specific Activity - as defined in 49 CFR 173.425.
    (3) Radioactive Article - as defined in 49 CFR 173.422.
    (4) A_1 and A_2 - as defined in 49 CFR 173.403(a) and (b), respectively.
    (5) Greater than A_1 or A_2, - a quantity of radioactivity in excess of A_1 or A_2, but less than "Highway Route Controlled".
    (6) Highway Route Controlled - as defined in 49 CFR 173.403(l).

2. **Health and Safety**

    Safety Inspection - to be performed in accordance with ID 5480.1 Chapter III, Part C.

3. **Signatures**

    All entries must be filled (either with the appropriate name or N/A.)

4. Transportation (Trans.)

    a. Driver or carrier representative, assumes custody and responsibility for shipment.
    b. Traffic agent represents final release authorization from INEL.

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OF FORM FROM
FORMS MANAGEMENT OFFICE**

APPENDIX D
SHIPPING DOCUMENT

EG&G Idaho, Inc.

FORM EG&G-061
(Rev. 08-90)

Number SD

SHIPPING DOCUMENT

Date Returned ______________________

Return for Credit ☐

Ship for Analysis ☐

EG&G Idaho, Inc., Order No. ______________________

Material for Repair or Exchange ☐

EG&G Idaho, Inc., Charge No. ______________________

Other
Explain Below ☐

Required Accounting Action ☐

Vendors RMA No. ______________________

Method of Shipment ______________________

Collect ☐ Prepaid ☐

Vendors and Person Contacted for Return

Material Shipped to

SAMPLE

Description of Material Being Shipped

OBTAIN LATEST REVISION OF FORM FROM FORMS MANAGEMENT OFFICE

Detailed Reason for Return

For [illegible] Only

Signature of Person Shipping Material

Signature of Person Receiving Material

+ SHIPPING ADDRESSES

EG&G Idaho Inc. For U.S. D.O.E.
765 Lindsay Blvd.
Idaho Falls, Idaho 83415

EG&G Idaho, Inc. For U.S. D.O.E.
CF-601/Order No. ______________________
Idaho National Engineering Laboratory
Scoville, Idaho 83415

MAIL & PARCEL POST
EG&G Idaho, Inc. For U.S. D.O.E.
P.O. Box 1625
Order No. ______________________
Idaho Falls, Idaho 83415

ATTENTION - REPAIR ORDERS: Please advise estimated repair cost and delivery date. DO NOT proceed with repairs until you have received authorization to do so. Material should be returned by same method received. Excess transportation cost will be charged to shipper unless authorized. Telephone 208-526-2444 for further information.

BILLING INSTRUCTIONS
Mail Invoice in Duplicate
To: ACCOUNTS PAYABLE SECTION
P.O. Box 1625
Idaho Falls, Idaho 83415

TRAFFIC COPY

Appendix M
Evaluation of VVM and Testing Sites at RWMC

APPENDIX M

ERP-VVED-065, ENGINEERING DESIGN FILE EVALUATION OF VAPOR VACUUM MONITORING AND TESTING SITES AT THE RWMC

G&G Idaho, Inc.
FORM EG&G-2631 (Rev.12-88)

Project File Number ____________
EDF Serial Number ERP-VVED-055
Functional File Number ____________

ENGINEERING DESIGN FILE

Project/Task BWP Vapor Vacuum Extraction Project
Subtask Design, Fabrication, Installation and Operation

EDF Page 1 of 25

Subject : Evaluation of vapor vacuum monitoring and testing sites at the RWMC.

Abstract: Over 130 potential vapor sampling sites are located at the Radioactive Waste Management Complex (RWMC) that may be available for use in the Vapor Vacuum Extraction (VVE) project. This study was conducted to determine which sites are available for this program and to evaluate whether the sites can be utilized to remove vapors for monitoring or treatment (extraction well) or to perform geologic characterization tests (permeability). Data on all the sites at the RWMC are compiled and their potential usefulness evaluated for the VVE Project. All potential vapors sampling sites located from land surface to the aquifer (585 ft depth) and within 3000 ft of the RWMC are evaluated. These sites include open (uncased) wells, neutron access tubes, ground water wells, subpit sampling wells, Transuranic Storage Area (TSA) monitoring ports, and suction lysimeters. Most sites can be used for periodic sampling but only a few are available for purposes such as geologic characterization tests. The diversity in different potential monitoring sites may affect the comparability of samples. Monitoring sites should be examined prior to use to determine if they are: (a) available for use without conflicting uses, (b) in a suitable location, (c) constructed in a manner that can be readily used or easily modified, and (d) the correct depth and diameter. Fifty-five nitoring sites are located in surficial sediments in the Subsurface Disposal Area up to sixty-four sites in the waste at the Transuranic Storage Area. Twenty-four potential sampling sites are located in basalt and interbeds below the surficial sediments. These include: 7 uncased wells, four perched water monitoring wells, 6 ground water wells, and 7 suction lysimeters in three wells. This evaluation indicates there are numerous potential sampling sites that may be used by the VVE Project within the surficial sediments, basalts, and sedimentary interbeds at the RWMC.

Distribution (complete package)

N. W. Spang, J. B. Sisson, T. D. Chatwin, F. A. Davies, R. M. Lugar, T. B. Arrington and J. M. Hubbell

Distribution (cover sheet only): Project EDF file log, EDF serial no.log

Author Joel Hubbell J. M. Hubbell	Dept. F520	Reviewed JBSisson	Date 5/24/91	Approved	Date 6/21/91

Introduction

This report provides information on open wells, sampling devices, monitoring wells, and other devices installed at the Radioactive Waste Management Complex (RWMC) that can be used by the Vapor Vacuum Extraction project (VVE) to sample or test portions of the vadose zone. These openings are collectively referred to as sites. The vadose zone is the area that extends from land surface to the Snake River Aquifer at a depth of approximately 585 ft. This compilation includes all known sites available within 3000 ft. of the RWMC including the Subsurface Disposal Area (SDA) and the Transuranic Storage Area (TSA). It includes an evaluation of various sites for their potential use in the VVE project for collection of vapor samples or for determination of air permeability. Information presented on these sites at the RWMC have been taken from several sources. It is assumed this information is accurate and reflects the configuration of the sites at the time of writing. Surveyed coordinates of sites are included in Appendix A. Sites not included in this appendix have not been surveyed. Information is presented on open wells in the first section and is followed by information on other sites at the RWMC.

Open Wells

Ten wells are located at the RWMC that are not completed or scheduled for installation of instrumentation. The wells range in depth from 50 to 550 ft. Figure 1 presents the locations of these wells and Table 1 presents information on the wells. These wells are evaluated as to their possible use in the VVE system. Eight of the ten wells listed in Table 1 can be utilized if they are: (a) completed in a manner that can be used, and (b) in a location suitable for testing, monitoring, or extracting vapor. Some of these wells are currently used or have a specific purpose, such as monitoring perched ground water. The use of wells for the VVE project may eliminate or adversely affect current uses. Well 8802D is included in this table since it can be used for vapor monitoring, even though it has been instrumented. Appendix B presents information for wells used by the VVED Project.

Wells were evaluated to determine if they could be utilized for: (a) testing with a packer system or (b) installation of permanent vapor ports. The packer system is used to determine the vertical distribution of volatile contaminants near the well and/or determination of horizontal permeability of rock. The permanent vapor ports can be used to monitor vapors over time or to extract vapors for treatment. Installation as permanent vapor ports involves using the well as completed or modifying of the well (drilling or reaming). Well details which may effect the evaluation are presented in Table 1.

All wells listed in Table 1 have the potential to be used by the VVE program. However, four wells (77-2, 78-1, USGS-92, and 8802D) are used or have been used for perched water monitoring. Their use in this project must be weighted against potential uses of the perched water monitoring wells. Only well USGS 92 is being monitored on a regular basis. The remaining

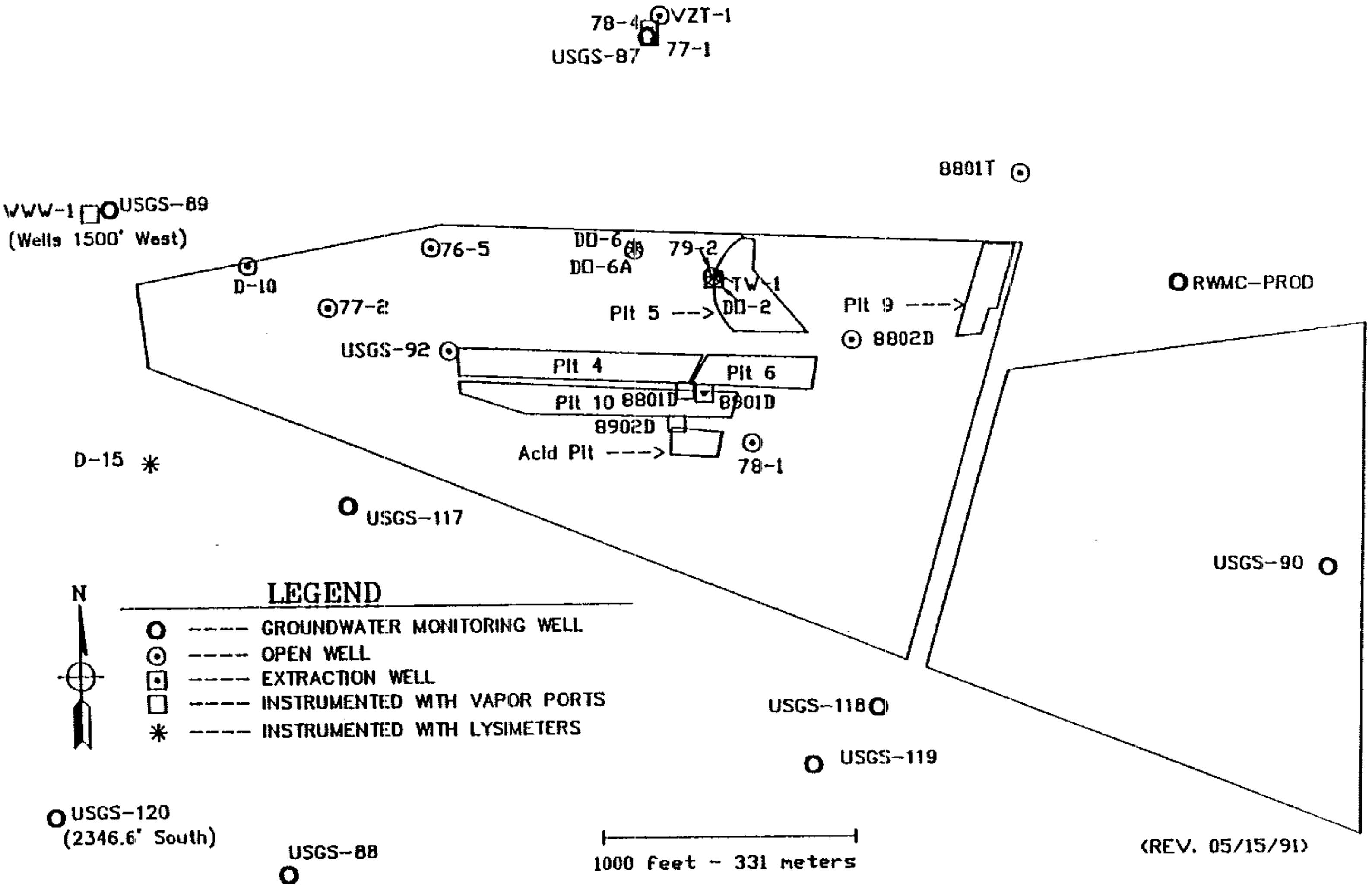


Figure 1. Location of potential monitoring sites below the surficial sediment at the RWMC.

Table 1. Summary information on open wells at the RWMC.

Well Identification	Completion Depth (ft)	Planned/Current Use	Potential use for VVE?
<u>Shallow Depth</u>			
77-2	86	Perched water monitoring	Limited
78-1	82	Perched water monitoring	Limited
DO-6A	49	None/none	Yes
8801T	50	Test drilling (practice)	Yes
VZT-1	134	USGS vapor test	Yes
<u>Intermediate Depth</u>			
USGS-92	214	Perched water monitoring	Yes
76-5	245	None/none	Yes
79-2	221	None/none	Yes
D-10	238	None/none	Yes
8802D	221	Perched water monitoring	Yes
<u>Deep Depth</u>			
USGS-118	550	None/none	Yes

perched wells will be monitored in the future. Wells 77-2 and 78-1 have PVC casing from land surface to total depth. The PVC casing is cemented to the surface casing for several feet. Well 8802D is completed with screen from 210.6 to 220 ft below land surface.

Wells listed in Table 1 are readily accessible with exposed casing at land surface and sealed well caps except well VZT-1. This well is unmarked and abandoned. Well VZT-1 was drilled by the USGS for use in vadose zone monitoring. The well has no surface casing and was covered with a sheet of plywood. The well and plywood were apparently buried while grading the road. It is assumed the well is still covered with plywood and can be accessed for use once located by surveyors. Well 76-5 is not recorded as being backfilled or instrumented following drilling. This well was surveyed and excavated in spring, 1991. It is assumed Well 76-5 is in usable condition.

Wells D10 and USGS 118 have "temporary" casing in them that needs to be removed prior to testing or completing the cased portions of the wells. This casing is not cemented in place and should be able to be removed.

Evaluation of Open Wells

Vertical Distribution/Permeability

Two uses for open wells at the RWMC are to (1) perform vapor extraction to determine concentration with depth and (2) perform permeability tests within the wells. These tests require the well not have casing and to be of sufficient diameter to allow insertion of the tools to perform tests. Open wells at the RWMC vary in diameter from 3.650 to approximately 7 7/8 inch. Well 8802D has 2.245 in. screen covering the open interval. Table 2 presents a list of suitable wells, along with diameter and potential test intervals. This evaluation indicates 9 wells, with a combined vertical length of 1358 ft, are available for testing. Wells USGS-118 and D-10 require casing be removed prior to testing the cased portions of the wells. Well 8802D may be tested over the screened interval. Wells 77-2 and 78-1 cannot be used to determine permeability and have limited use for vertical distribution due to the configuration of the casing in the wells.

Well 79-2 is located 12 feet from vapor monitoring well D-02. The small distance between these wells allows cross-borehole testing to be performed. This may allow determination of tracer travel times, diffusion coefficients, dispersivities, and permeabilities within basalt and 110-ft sedimentary interbed between the wells. Similar test could be performed between well VZT-1 and wells 78-4 and 77-1 (66 and 88 feet distance between wells, respectively).

Table 2. Evaluation of suitability of wells for vertical distribution and permeability tests.

Well Identification	Vert. Dist./ Permeability	Inner Diameter Inch	Depth Interval (ft)
Shallow Depth			
77-2	No/No	3" casing to 86'	
78-1	No/No	3" casing to 83'	
DO-6A	Yes/Yes	3.650	7 - 50
8801T	Yes/Yes	5 7/8	14.4 - 50.7
VZT-1	Yes/Yes	5 7/8	0 - 134
Intermediate Depth			
USGS-92	Yes/Yes	3.650	12 - 214
76-5	Yes/Yes	5 7/8 4 7/8	9.4 - 123 123 - 245
79-2	Yes/Yes	5 7/8 4 7/8	20 - 160 160 - 212
D-10	Yes/Yes	7 7/8	12 - 224
8802D	No/Yes	2.245	210.6 - 220.6
Deep Depth			
USGS-118	Yes/Yes	>4.5 4	10? - 222 222 - 550

Conversion to Permanent Monitoring or Extraction Wells

Table 3 presents a summary of the evaluation of conversion of open wells to permanent monitoring or extraction wells. Criteria used for the evaluation are: (1) location relative to vapor plumes mapped during the 1987 soil gas survey and other vapor monitoring wells and (2) depth, where monitoring or extraction wells should be deeper than 50 feet. Wells with smaller diameters are noted under comments.

Conversion of a well to permanent monitoring well requires the inner diameter of the well be adequate for installing instruments. The procedure used in installing instruments in well 8801D, D02, and 8902D requires at least a 5 inch diameter well. Installation procedures can be modified to install instruments in smaller diameter wells (particularly at depths below 200 ft). The assumption is made that well diameter will not be a limiting factor in final design (i.e. the wells will be used as is, or deepened, with no expansion of well diameter). Cost benefit analyses are required to determine the economics of widening well diameters. Extraction wells should not be limited by diameter.

Wells D06A, 8801T, VZT-1, 76-5, 79-2, D10, and USGS 118 can be used for monitoring or extraction by the VVE program. However, perched water monitoring wells 78-1, 77-2, 8802D and USGS-92 should be reserved for monitoring perched water. Wells D06A and 8801T have limited usefulness due to shallow depths. Well VZT-1 is located north of the SDA away from the vapor plume.

Other Sampling Sites

This evaluation includes an examination of all other sites (i.e. neutron access tubes, ground water monitoring wells, subpit sampling wells, and suction lysimeters) that could be used to collect vapors from discrete depths within the vadose zone at the RWMC. Data from potential sampling sites within the Transuranic Storage Area are included.

Neutron Access Tubes

Neutron access tubes are steel pipes buried in surficial sediments with a removable cap at land surface and an open end at the bottom. A neutron source and detector is lowered down the access tube to obtain data on the moisture content adjacent to the tubing. Access tubes were installed so the bottom rests on a thin layer of sediment on top of basalt. Gas samples can be withdrawn from the basalt/sediment interface by sealing the tube top and withdrawing gas from the tubing. Information on neutron access tubes are presented in Table 4. Locations of neutron access tubes are presented in Figure 2. Figure 2 includes all monitoring sites within sediment above the first layer of basalt. All of the access tubes are useful for vapor sampling from the surficial sediment/basalt contact. The limited open area at the

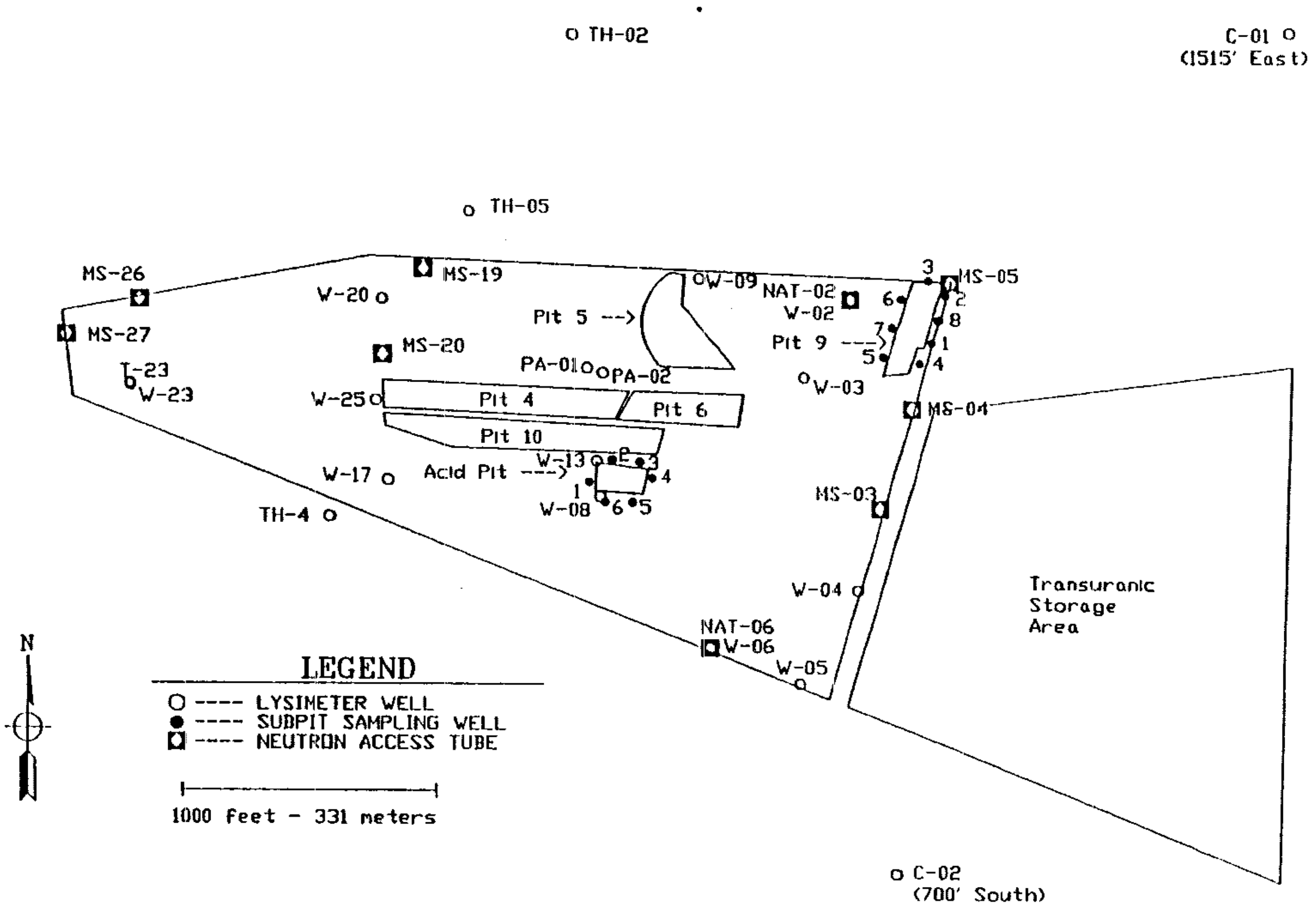
Table 3. Evaluation of suitability for conversion of well to permanent monitoring or extraction well.

Well Id.	Conversion to: Monitoring/ Extraction	Comments
Shallow Depth		
77-2	No	Used for perched water monitoring
78-1	No	Used for perched water monitoring
DO-6A	Yes	Shallow depth and small diameter limits usefulness for monitoring, shallow depth limits usefulness for extraction, good location
8801T	Yes	Shallow depth and location limits usefulness for monitoring or extraction
VZT-1	Yes	Location limits usefulness for monitoring and extraction
Intermediate Depth		
USGS-92	No	Used for perched water monitoring
76-5	Yes	Good location, size and depth
79-2	Yes	Located adjacent to well D-02, good location for extraction, good size and depth
D10	Yes	Good location, size and depth for monitoring/extraction
8802D	No	Used for perched water monitoring
Deep Depth		
USGS 118	Yes	Good location for monitoring, poor for extraction; size is small for monitoring, good to excellent depth

Table 4. NEUTRON ACCESS TUBES AT RWMC

Identification	Depth (ft-in)	Comments
MS 3*	10′ 6"	Installed by USGS, 2", Sch. 40
MS 4	10′ 0"	Installed by USGS, 2", Sch. 40
MS 5	9′ 0"	Installed by USGS, 2", Sch. 40
MS 19	15′ 0"	Installed by USGS, 2", Sch. 40
MS 20	4′ 0"	Installed by USGS, 2", Sch. 40
MS 26	11′ 5"	Installed by USGS, 2", Sch. 40
MS 27	12′ 5"	Installed by USGS, 2", Sch. 40
NAT-02	14′ 6"	Installed by EG&G, 1.5", Sch. 40
NAT-06	10′ 6"	Installed by EG&G, 1.5", Sch. 40

* Identified as monitoring stations (MS) in EG&G Drawing Number 416511.



(rev. 02/19/91)

Figure 2. Locations of potential gas sampling sites in surficial sediments at the RWMC.

bottom of the access tubes reduces their usefulness for extracting vapors beyond sampling. Neutron access tubes labeled MS have not been monitored since the mid 1980's and can be used by the VVE project. Neutron access tubes labeled NAT had monitoring discontinued in 1991. Injection or extraction of large volumes of air through the tubes would tend to dry sediments adjacent to the tubes, biasing subsequent moisture measurements.

Ground Water Wells

Several ground water monitoring wells are completed with portions of the wells open above the water table. These wells can be sampled in a similar manner as neutron access tubing by attaching a vacuum source at land surface and withdrawing vapor until the sample is collected. Table 5 presents information on ground water monitoring wells at the RWMC along with the potential for vapor sampling. Well locations are presented in Figure 1. Several wells are completed with casing extending beneath the water table; however, the water level fluctuates significantly so sampling of vapors above the water table may be possible if the water table is low at the time of sampling. The water table can be depressed in well 119 by pumping the well and removing vapors from the casing with a vacuum pump. Ground water monitoring wells are monitored on monthly to quarterly basis by the USGS so extraction of vapors for the VVE system may interfere or bias subsequent sampling activities.

Subpit Sampling Wells

Access wells are installed in surficial sediments around pit 9 and the acid pit (Table 6 and Figure 2). Locations of access wells included in Figure 2 are visually placed since they have not been surveyed. Access wells were installed by pressing an approximate 4.5 inch outer diameter sampling tube through surficial sediment to basalt (while removing sediment for analyses), inserting a 3 inch inner diameter fiberglass tubing (open at the bottom) to the bottom of the hole, and withdrawing the 4.5 inch tubing. Three feet of surface casing is cemented in place to protect the installation. Air samples can be withdrawn from outside the fiberglass tubing, collecting vapors from the full length of the well. Withdrawing vapor from the interior of the tubing may provide samples from the bottom of the well but may allow air to be obtained from the annular space around the well. Some fiberglass tubes can be withdrawn allowing access for packers to test or sample discrete portions of the wells. Long term monitoring has not been planned for these monitoring wells due their recent installation. Well usage will have to be negotiated with the respective program.

TSA Monitoring Ports

Potential vapor monitoring access ports were installed in waste buried in the Transuranic Storage Area (TSA) in 1974 (Figure 3). Detailed information on these access ports is found in annual reports by Wickham and Janke (1980) and Janke and Zahn (1982). The monitoring sites are located

Table 5. Ground water monitoring wells at the RWMC.

Well Identification	Depth* Open (ft)	Water Table Depth* (1/1991)	Able to collect vapor samples W/O Pumping	With Pumping
USGS 87	585 - 640	587	Occasionally**	Occasionally
USGS 88	587 - 635	589	Occasionally	Yes
USGS 89	576 - 646	601	Yes	Yes
USGS 90	580 - 626	582	No	No
USGS 117	555 - 653	585	Yes	Yes
USGS 119	639 - 705	604	No	Yes
USGS 120	638 - 705	615	No	No
RWMC Production	560 - 635	unknown	Yes	Yes

* Depths are rounded to nearest foot.

** These wells can be sampled if the water table declines so the open portion of the well is exposed to the vadose zone.

Wells 117, 119, 120 and RWMC Production well are screened adjacent to the listed interval. The remaining wells do not have screen.

Table 6. Information on Subpit sampling wells at the RWMC.

Identification Number	Depth (ft-in)
Acid Pit Penetration	
1	18-0
2	18-0
3	17-9
4	19-6
5	22-9
6	18-11
Pit Nine	
1	22-0
2	16-11
3	9-9
4	18-0
5	21-8
6	7-8
7	15-4
8	15-0

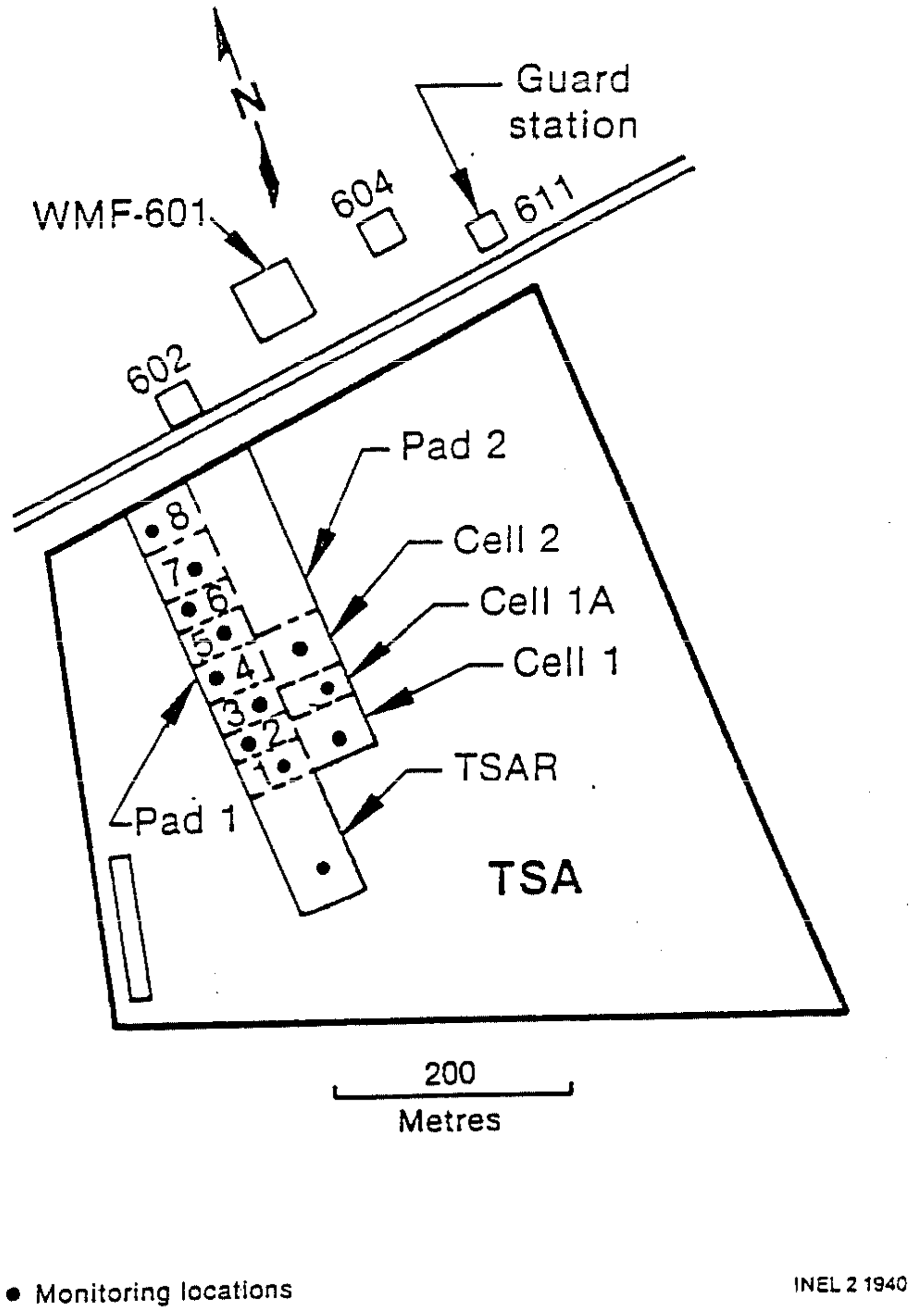


Figure 3. Location of potential monitoring sites at the Transuranic Storage Area, RWMC.

within the above grade containment facility in the TSA. The transuranic wastes are stored in containers on an asphalt pad with a geomembrane and sediment over the containers. Storage areas are separated into 8 cells in Pad 1 and 3 cells in Pad 2 by earth fill fire breaks.

The potential vapor sampling sites are eight inch diameter air circulation pipes or three inch diameter instrument guide pipes. Pipes were installed to provide access for gas sampling in the waste at discrete depths and to protect instrument lead wires that were monitored at land surface, respectively. Samples can be obtained from air circulation pipes by placing a connector on the tubing at land surface and withdrawing air samples. The instrument guide pipes can be used for vapor sampling if they are not sealed to preclude transfer of air within the pipe. The instrument guide pipes can be sampled by sealing the pipe at land surface and withdrawing air. These access tubes are not used so their use by the VVE project would not interfere with other activities. These installations can be used for either sampling or extraction of vapor. The sampling ports provide access to different layers and locations within the buried waste. These access ports have not been used since the mid-1980's. Results from a soil gas survey in 1987 indicated organic vapors were present within the waste in the TSA (Laney et. al., 1988). Air samples were collected from two levels within four of the cells and tested for flammable gasses in the early 1980's (Anonymous, 1985).

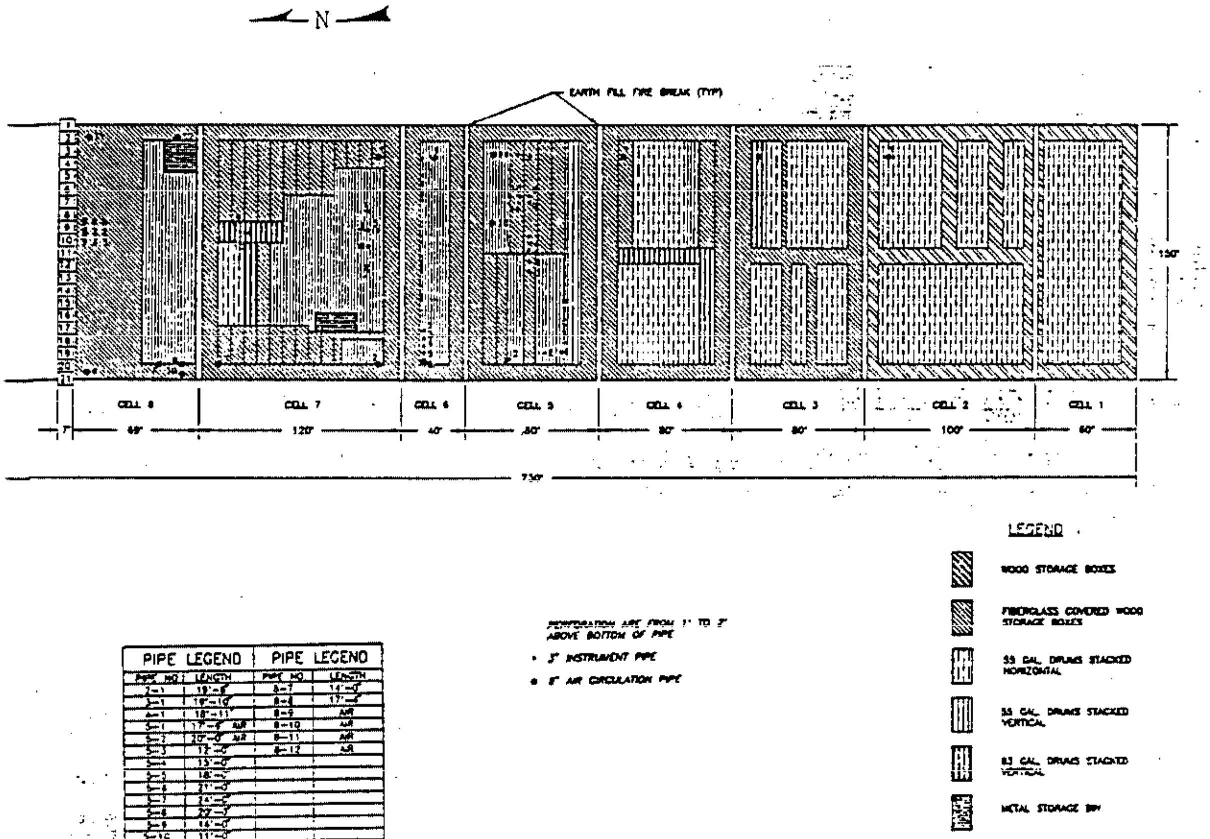
Potential monitoring ports in Pad 1 are presented in Figure 4 (EG&G Drawing Number 155663). Eight air circulation pipes are located within 7 of the 8 cells and 40 instrument guide pipes in the four northern most cells. Figure 5 presents a schematic cross section through cell 8 of TSA Pad 1. A portion of cell 5 was retrieved so many if not all of the potential monitoring sites were removed.

Five air circulation and 11 instrumentation guide pipes are located in cells 1 and 2 of Pad 2 (Figure 6, EG&G Drawing Number 158273). Pad 2 has three cells (1, 1A, and 2) open to the atmosphere and one cell covered with an air support building (ASB). Figures 7 and 8 present schematic cross-sections within cells 1 and 2. The TSA-R storage area, south of Pad 2, contains one potential sampling site (Figure 3 and Figure 9). Sampling this site would provide samples from the upper portion of the waste.

The Transuranic Storage Area contains up to 61-3 inch instrument guide pipes and 13-8 inch air circulation pipes available to extract or sample vapors from within the stored waste. The number of access ports that are available and operational is unknown so field examination and testing is required prior to use.

Porous Cup Suction Lysimeters

The only other "access sites" that could withdraw air samples from discrete depths at the RWMC are suction lysimeters installed within the surficial sediments and sedimentary interbeds. The depths of the instruments are presented in Table 7. Well locations with lysimeters in surficial sediments are presented in Figure 2 and lysimeters in basalt and interbeds



PIPE LEGEND		PIPE LEGENO	
PIPE NO	LENGTH	PIPE NO	LENGTH
2-1	19'-6"	8-7	14'-0"
3-1	19'-10"	8-8	17'-0"
4-1	18'-11"	8-9	AIR
5-1	17'-6" AIR	8-10	AIR
5-2	20'-0" AIR	8-11	AIR
5-3	12'-0"	8-12	AIR
5-4	13'-0"		
5-5	18'-0"		
5-6	21'-0"		
5-7	24'-0"		
5-8	22'-0"		
5-9	14'-0"		
5-10	11'-0"		
5-11	17'-0"		
5-12	20'-0"		
5-13	22'-0" AIR		
5-14	22'-0"		
5-15	24'-0"		
6-1	20'-0"		
6-2	17'-0"		
6-3	20'-0"		
6-4	14'-0"		
6-5	11'-0"		
6-6	20'-0"		
7-1	20'-0"		
7-2	22'-0"		
7-3	20'-0"		
7-4	17'-0"		
7-5	11'-0"		
7-6	8'-0"		
7-7	14'-0"		
7-8	22'-0"		
7-9	17'-0"		
7-10	14'-0"		
7-11	20'-0"		
8-1	18'-0"		
8-2	13'-0"		
8-3	24'-0"		
8-4	24'-0"		
8-5	11'-0"		
8-6	21'-0"		

Figure 4. Potential monitoring sites in Pad 1 of the Transuranic Storage Area.

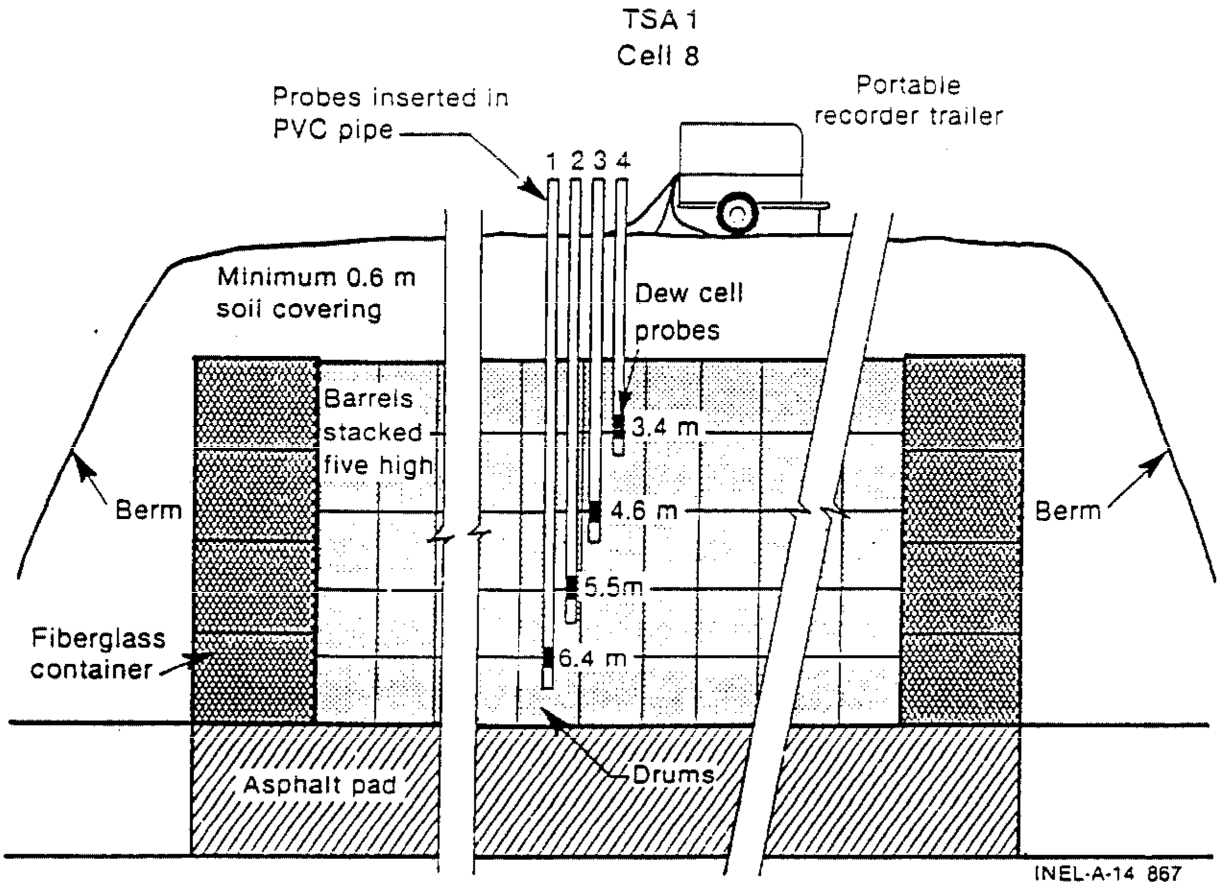
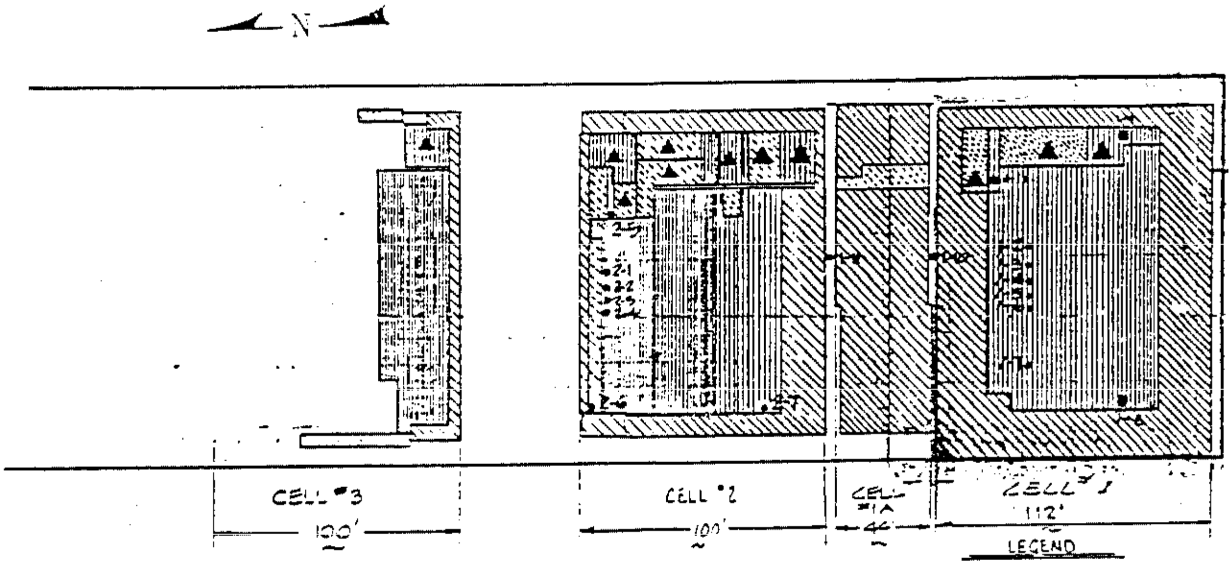


Figure 5. Cross-section of vapor sampling port locations in TSA 1, cell 8.



LEGEND

▨ WOOD STORAGE BOXES

▨ FIBERGLASS COVER WOOD STORAGE BOXES

▥ 55 GAL. DRUMS STACKED HORIZONTAL

▥ 55 GAL. DRUMS STACKED VERTICAL

▥ 85 GAL. DRUMS STACKED VERTICAL

▩ METAL STORAGE BIN

▲ CONTAINERS CONTAIN COMBUSTIBLE MATERIAL

PIPE LEGEND	
PIPE NO.	LENGTH
1-1	20'-0"
1-2	8'-6"
1-3	11'-0"
1-4	14'-0"
1-5	17'-0"
1-6	20'-0"
1-7	15'-0"
1-8	AIR
1-9	AIR
1-10*	—
1-11*	—
2-1	8'-0
2-2	8'-0
2-3	8'-0
2-4	8'-0
2-5	AIR
2-6	AIR
2-7	AIR

PERFORATION ARE FROM 1' TO 2' ABOVE BOTTOM OF PIPE

- • 3" INSTRUMENT PIPE
- ● 8" AIR CIRCULATION PIPE
- * SOIL MOISTURE PROBE

Figure 6. Potential monitoring sites in Pad 2, TSA.

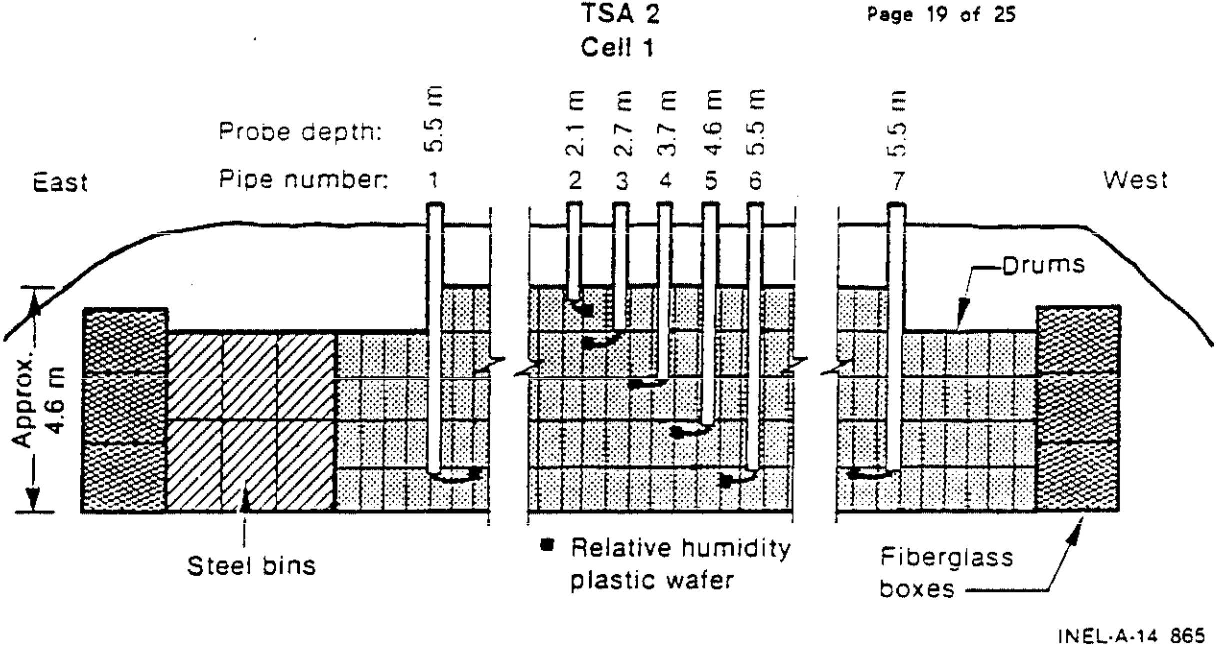


Figure 7. Cross section through TSA 2, cell 1 showing potential vapor sampling locations.

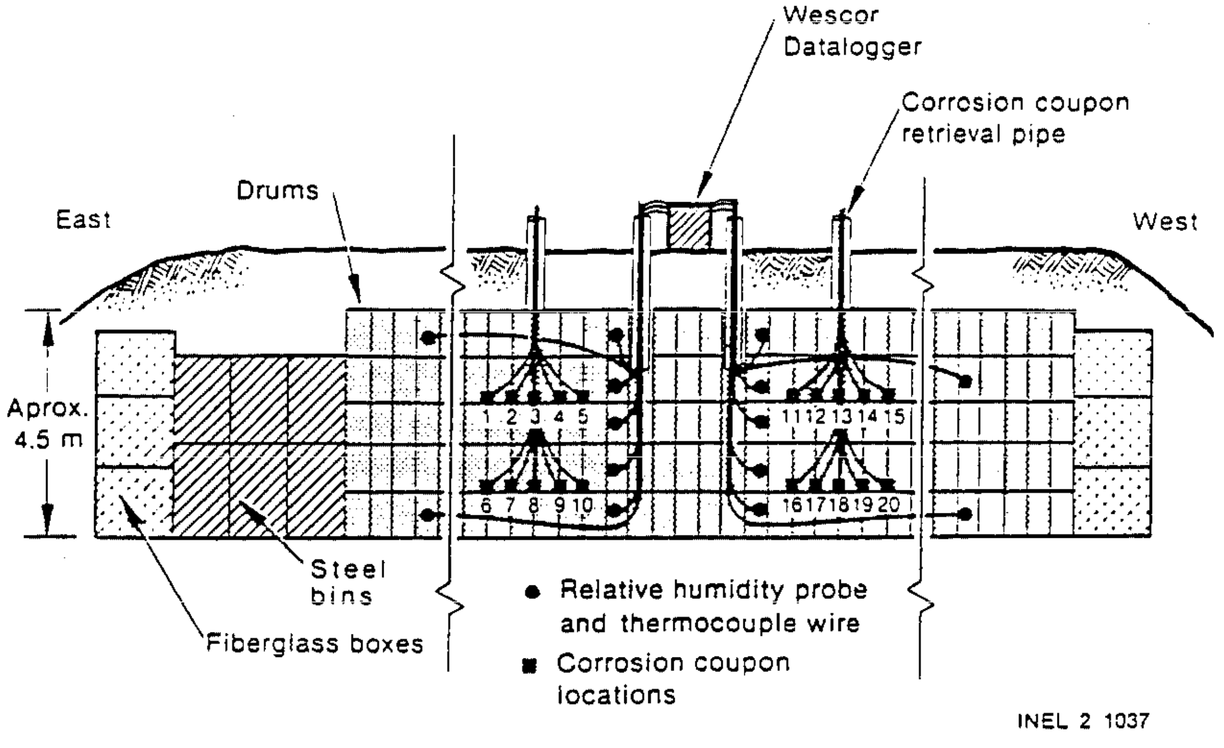


Figure 8. Cross-section through TSA-2, cell 2 showing location of potential gas sampling locations.

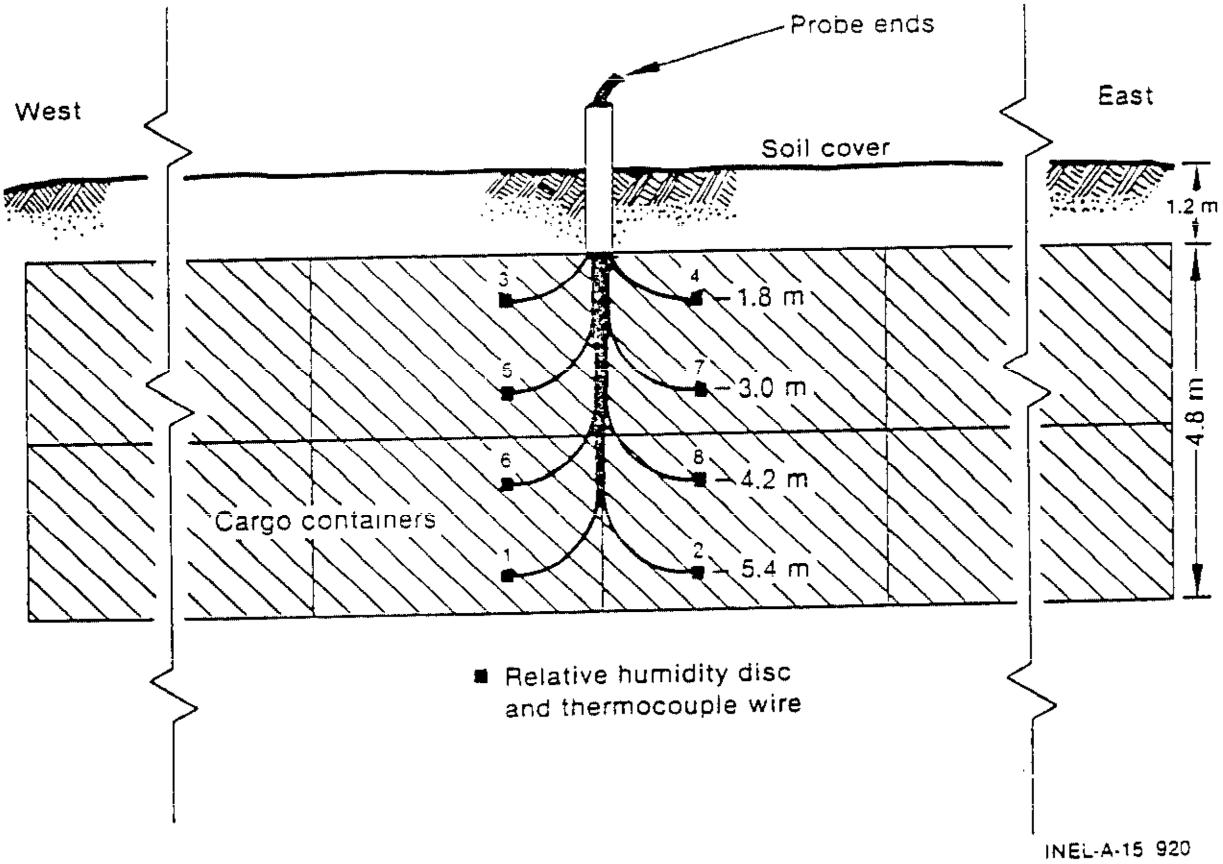


Figure 9. Cross section of TSA-R, showing potential gas sampling location.

Table 7. Porous cup lysimeters at the RWMC.

Instrument Number	Date Installed	Depth Installed (ft-in.)	Comments
Well D06			
DL01	09/12/86	88-0	
DL02	09/12/86	44-0	
Well TW1			
DL03	06/25/87	226-11	
DL04	06/25/87	101-8	
Well D15			
DL05	09/15/87	222-11	Organic vapors detected in well (100') following drilling using a HNU photoionization detector
DL06	09/15/87	97-11	
DL07	11/04/87	32-2	
Auger Hole W02			
L01	06/17/85	14-0	
Auger Hole W03			
L02	06/17/85	10-6	
Auger Hole W04			
L03	06/19/85	24-6	
L04	06/19/85	15-5	
L05	06/19/85	6-2	
Auger Hole W20			
L06	06/28/85	6-8	
Auger Hole W23			
L07	06/28/85	18-10	Organic vapor detected
L08	06/28/85	11-10	
L09	06/28/85	7-8	

TABLE 7. (continued)

Instrument Number	Date Installed	Depth Installed (ft-in.)	Comments
Auger Hole T23			
L10	07/02/85	19-0	Organic vapors detected
Auger Hole C02			
L11	07/03/85	4-4	
Auger Hole W08			
L12	07/09/85	22-1	
L13	07/09/85	11-4	
L14	07/09/85	6-2	
Auger Hole PA01			
L15	07/11/85	14-4	
Auger Hole PA02			
L16	07/11/85	8-8	
Auger Hole TH02			
L17	06/07/85	6-0	
Auger Hole TH04			
L18	04/23/85	4-0	
Auger Hole C01			
L19	08/06/86	17-8	
L20	08/06/86	7-5	
Auger Hole TH05			
L21	09/08/86	15-2	
L22	09/06/86	5-11	
Auger Hole W09			
L23	09/17/86	14-10	

TABLE 7. (continued)

Instrument Number	Date Installed	Depth Installed (ft-in.)	Comments
Auger Hole W05			
L24	09/22/86	15-11	
L25	09/22/86	10-0	
L26	09/22/86	6-8	
Auger Hole W06			
L27	09/23/86	11-9	
Auger Hole W25			
L28	09/24/86	15-6	Organic vapors detected while drilling
Auger Hole W13			
L29	09/20/90	14-0	
L30	09/28/86	6-8	
Auger Hole W17			
L31	09/29/86	19-7	
L32	09/29/86	10-11	

are presented in Figure 1. Thirty two suction lysimeters are located within surficial sediments and 7 lysimeters located in basalt and sedimentary interbeds. Concentrations of vapors in lysimeters probably represent vapor concentrations adjacent to the lysimeter. Vapor in the vadose zone comes into equilibrium with vapor in the lysimeters by moving through the water permeable ceramic cup of the lysimeter. Air samples can be withdrawn from lysimeters by pressurizing or evacuating air from one of the two sampling tubes to force air within the lysimeter out of the other tube at land surface. Deep lysimeters (D-prefix) need to have a partial vacuum applied to them prior to sampling to open a check valve between the porous cup and the body of the lysimeter.

Samples can be obtained periodically from lysimeters. These lysimeters can provide vapor samples from the specified sampling depths. Procedures to collect samples from lysimeters will be more rigorous than those required for other sampling sites. Suction lysimeters are not currently being used at the RWMC. They can be used for periodic sampling without interfering with other activities.

SUMMARY

There are over a one hundred and thirty potential vapor sampling sites at the RWMC. One hundred sampling sites are located within the surficial sediment or within the buried waste at the Transuranic Storage Area. These sampling sites include access tubes open at the basalt/sediment interface from neutron access tubes, subpit sampling wells, porous cup lysimeters, and access tubes placed in the stored waste at the TSA. Twenty potential vapor sampling sites are located below the surficial sediments within basalt and sedimentary interbeds. These include open wells, ground water monitoring wells, and suction lysimeters.

REFERENCES

Anonymous, 1985, Environmental Handbook for the RWMC and Other Waste Management Facilities, Appendix entitled "Modifications to TSA Operational Monitoring Recommended by the Monitoring Activities Review". October 31, 1985.

Janke, D. H. and T. P. Zahn, 1982, Annual Report 1981, Radioactive Waste Management Complex, EGG-2209, September 1982.

Laney, P. T. et. al., 1988, Annual Progress Report: FY-1987, Subsurface Investigations Program at the Radioactive Waste Management Complex of the Idaho National Engineering Laboratory, April 1988.

Wickham, L. E. and D. H. Janke, 1980, Annual Report -1979, Environmental Surveillance for the INEL Radioactive Waste Management Complex, EGG-2042, December 1980.

APPENDIX A

SURVEYED COORDINATES OF POTENTIAL VAPOR SAMPLING SITES

Locations of potential vapor monitoring sites that have been surveyed are included below. Sites not included in this table are presumed to have not been surveyed. Approximate coordinates were chosen for locating the unsurveyed sites shown in the figures.

Well	Northing	Easting	Elevation
76-5	669810.69	266045.00	5011.40
77-2	669579.38	265632.59	5014.40
78-1	669032.88	267306.00	5010.00
79-2	669689.50	267160.50	5011.00
8801T	670078.13	268382.93	5009.96
8802D	669434.60	267706.13	5009.00
C-01	670774.40	271231.40	5001.90
C-02	666807.20	268164.30	5033.20
D-10	669746.85	265320.98	5014.00
D-15	668975.92	264915.69	5011.00
DO-6	669806.04	266853.45	5012.10
DO-6A	669794.96	266850.56	5012.00
PA-01	669469.55	266949.49	5008.80
PA-02	669458.54	267015.43	5010.80
RWMC-PROD	669664.69	269000.81	5005.00
T-23	669406.32	265147.03	5012.00
TH-02	670763.77	266891.29	5016.60
TH-04	668888.09	265927.38	5010.00
TH-05	670075.64	266482.05	5002.81
TW-1	669686.66	267167.01	5011.30
USGS-087	670620.86	266927.76	5015.88
USGS-088	667361.44	265429.59	5020.42
USGS-089	669975.84	263277.48	5028.91
USGS-090	668535.38	269588.09	5010.21
USGS-092	669411.25	266109.49	5007.70
USGS-117	668804.33	265696.33	5012.00
USGS-118	668000.78	267783.00	5012.70
USGS-119	667773.86	267521.01	5031.00
USGS-120	665248.35	264506.91	5012.07
VZT-1	670700.88	266970.69	5018.00
W-02	669736.24	267990.96	5006.80

W-03	669434.38	267805.18	5007.20
W-04	668607.82	268016.40	5010.40
W-05	668241.77	267786.51	5010.00
W-08	668966.91	266999.36	5011.50
W-09	669816.54	267391.17	5008.80
W-13	669105.23	266985.86	5013.40
W-17	669028.72	266158.52	5013.50
W-20	669733.63	266137.97	5010.40
W-23	669397.67	265147.76	5012.30
W-25	669341.47	266113.61	5010.90
MS-04	669314.48	268230.94	5008.96
MS-05	669802.88	268378.30	5008.93
MS-19	669852.27	266302.02	5010.22
MS-26	669728.97	265185.53	5014.34
MS-27	669590.43	264896.38	5013.74
NAT-02	669736.22	267987.48	5009.87
NAT-06	668379.28	267428.78	5011.22

APPENDIX B

SAMPLING INTERVALS FOR VVE WELLS AT THE RWMC

Summary of monitoring intervals in vapor vacuum extraction program wells at the RWMC.

Well Number	Sampling Interval	Depth of Port
78-4	70.5 - 81.0	78.0
	114.5 - 122.0	119.0
	223.0 - 230.0	227.5
	250.0 - 256.0	253.0
	330.5 - 340.0	335.0
WWW-1	9.2 - 21.4	15.3
	39.0 - 63.5	48.0
	67.7 - 80.5	74.0
	98.7 - 123.7	112.0
	127.0 - 151.0	135.0
	170.0 - 188.0	180.0
	230.0 - 250.0	240.0
77-1	59 - 69	66
	97 - 104	104
	108- 114	112
	146 - 164	151
	181 - 224	191
	364 - 380	371
8801D	30.6 - 35.4	32.8
	48.0 - 53.0	50.5
	74.0 - 79.0	77.5
	90.0 - 95.0	92.5
	100.0 - 105.0	102.5
	128.6 - 133.6	131.0
	165.0 - 170.0	167.2
	190.0 - 195.0	192.5
	227.7 - 232.7	230.0
8902D	32 - 25.5	30
	48.6 - 43.5	46
	73 - 68	70.5
	105 - 99.5	104.5
	132 - 124	130
	180 - 175	179
	199.7 - 194.5	198.7
	221.4 - 238	229

D02	25.0 - 30.0	27.5
	57.0 - 62.0	62.0
	66.0 - 71.0	68.5
	97.0 - 101.0	100.0
	123.5 - 129.0	126.5
	163.0 - 168.0	165.5
	190.0 - 195.0	192.5
	227.5 - 232.9	231
8901D*	90 - 234	

All depths are in feet, relative to land surface.

* Well 8901D is the VVED extraction well. This well was drilled with a 9 7/8 in. bit from land surface to 90 ft depth, a 7 7/8 in. bit from 90 to 220 ft, and a 5 1/8 in. bit to 249 ft (the bottom of the well from 241 to 249 is filled with sediment that caved from the well). The well is completed with 8 in. casing from land surface to 89 ft (cemented in place). Four inch stainless steel screen extends from 241 to 82 ft with a 4 in. riser pipe (not slotted) from 82 to 72 ft depth. The 8 in. pipe and 4 in. riser pipe are connected with a K style packer at approximately 72 ft below land surface.

APPENDIX N

CLP Target Compounds and Required Quantitation Limits

APPENDIX N

Contents

1. ERP-SOW-47, Rev. 1, EG&G Idaho, Inc. Basic Ordering Agreement for Organics Analysis Performed for the Environmental Restoration Program at the INEL.
2. ERP-SOW-59, Statement of Work for Inorganic Analyses Performed for the Environmental Restoration Program at the INEL.